A McGRAW-HILL PUBLICATION JULY 1960
ONE DOLLAR

Power

the magazine of energy systems engineering

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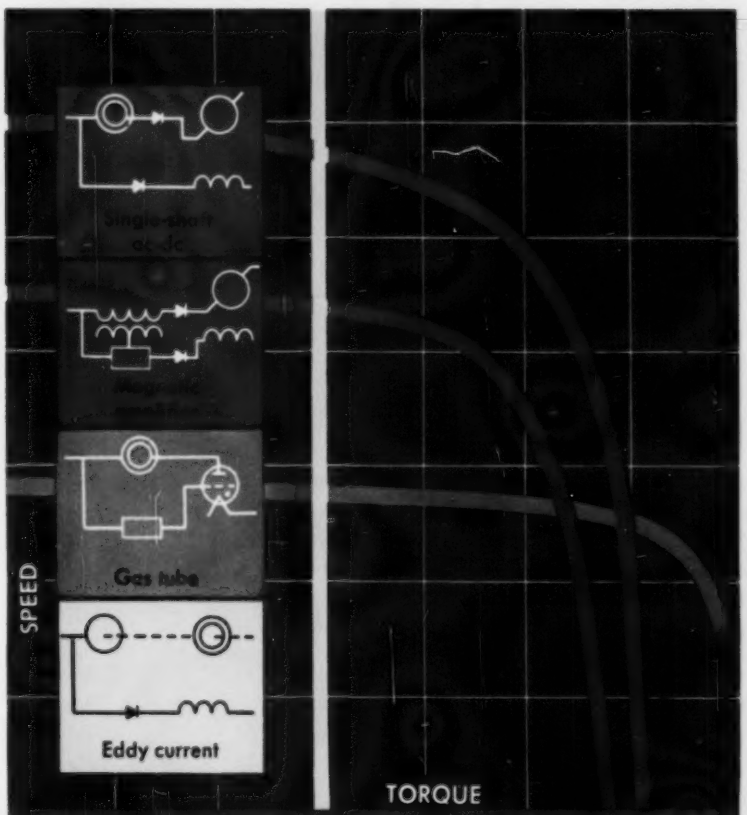

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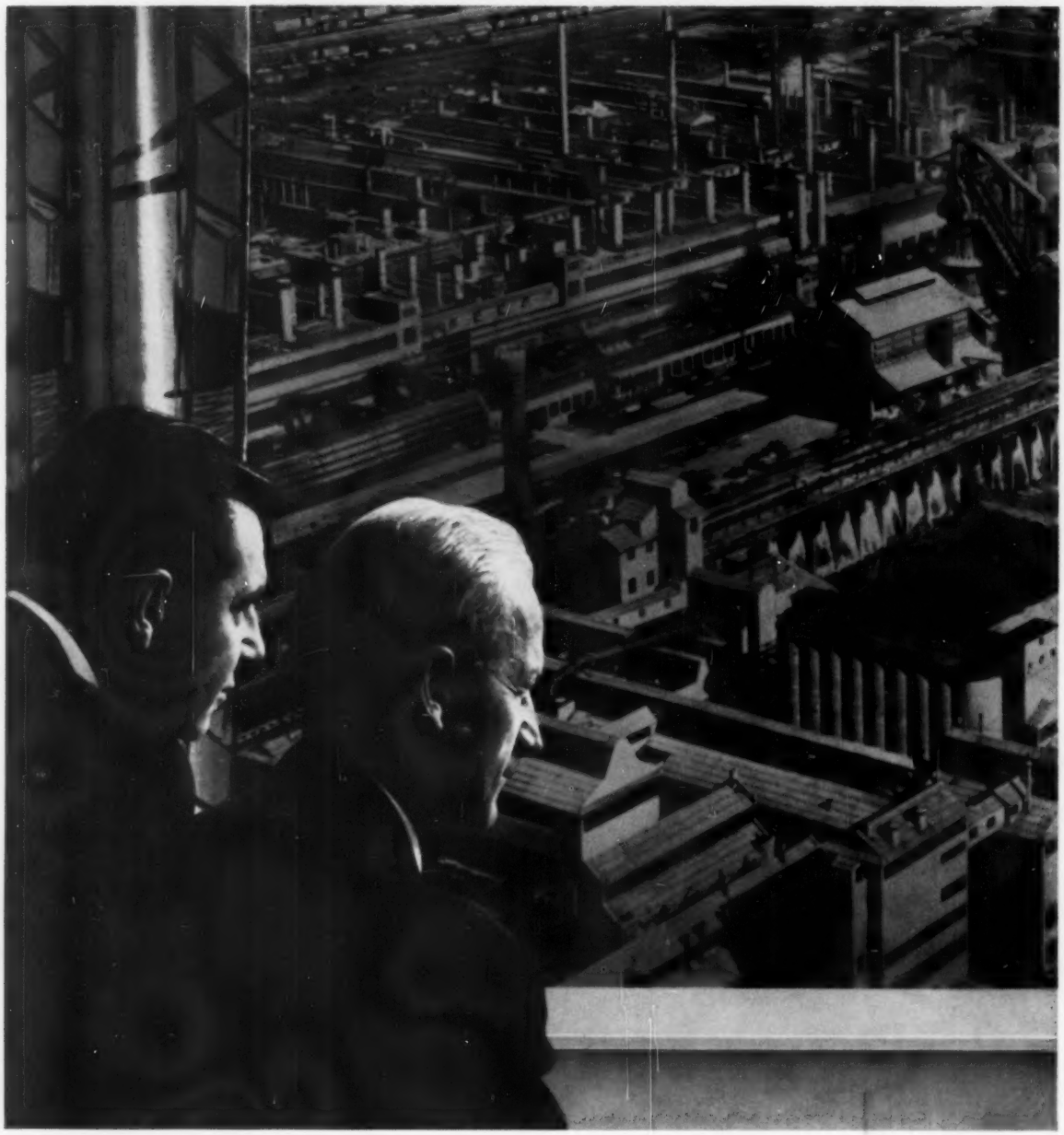

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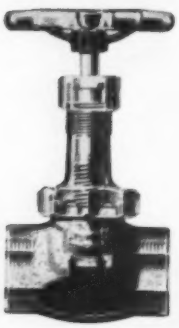

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For more facts circle 201 on Reader Service card, p 103

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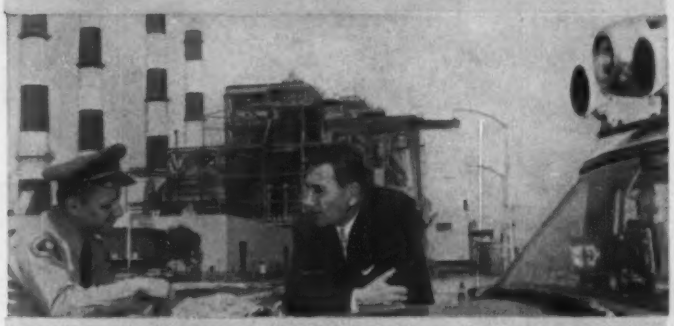
speaking of **Power**

STAFFER BELLAS starts day with Los Angeles air-pollution patrol . . .



bent on tracking down plants with smoking stacks and stopping . . .

over-the-road vehicles pouring out a too-heavy exhaust. Why? All part of Bob's 5-week Coast trip through L.A., San Francisco, Portland and Seattle gathering background data for POWER's major staff report on air pollution, scheduled for the December issue

Lou Lowley

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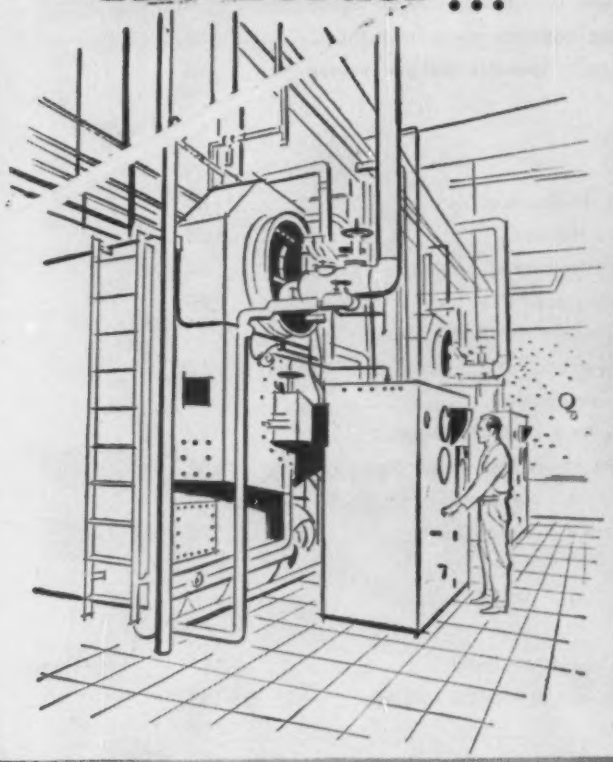
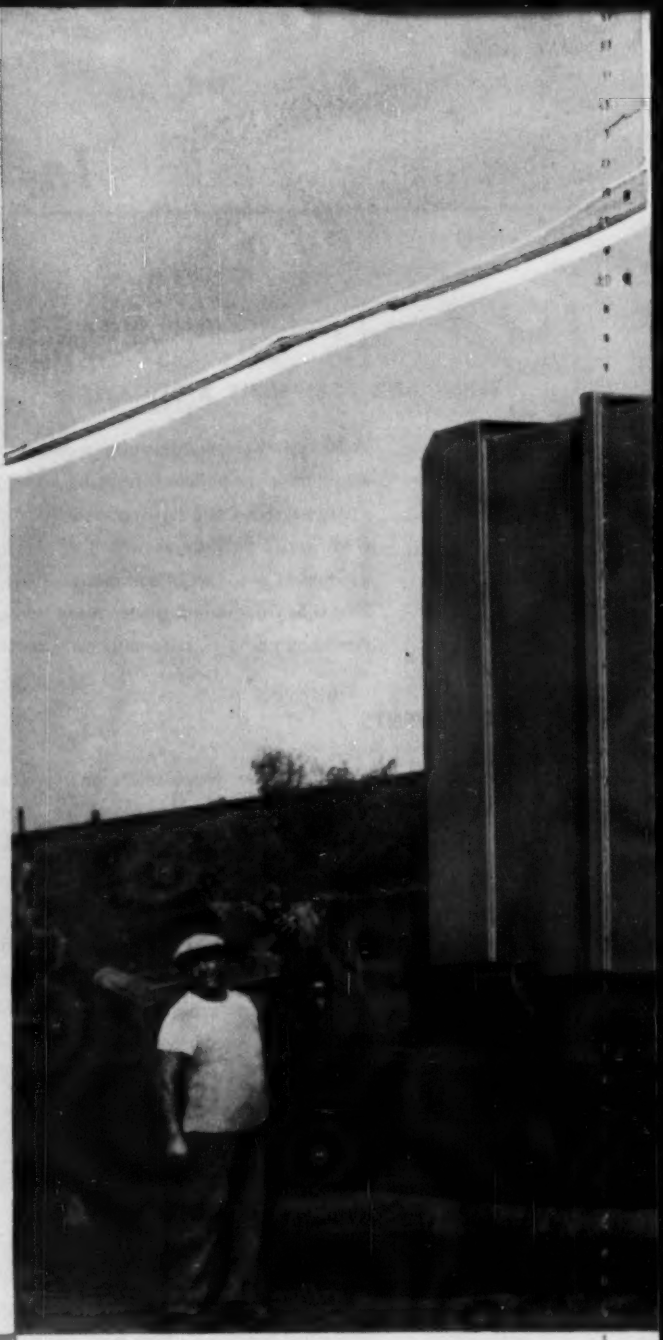
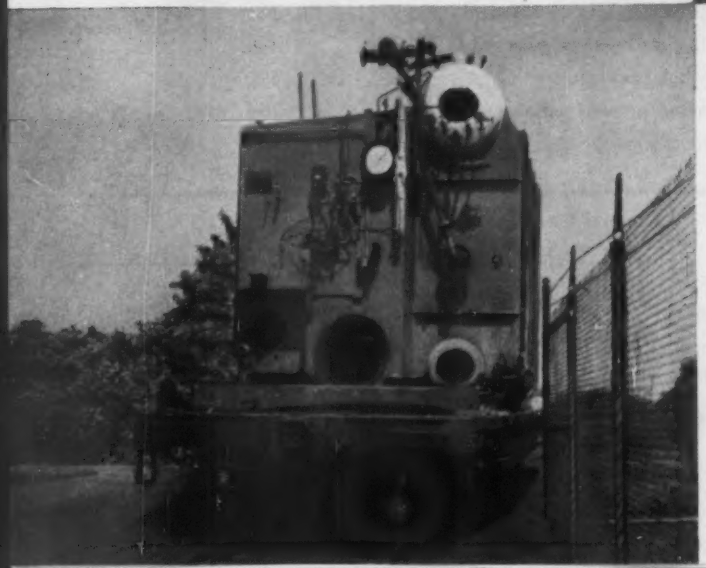
First B&W Shop-Assembled Boiler Ever Built Starts Life #2 South of The Border...



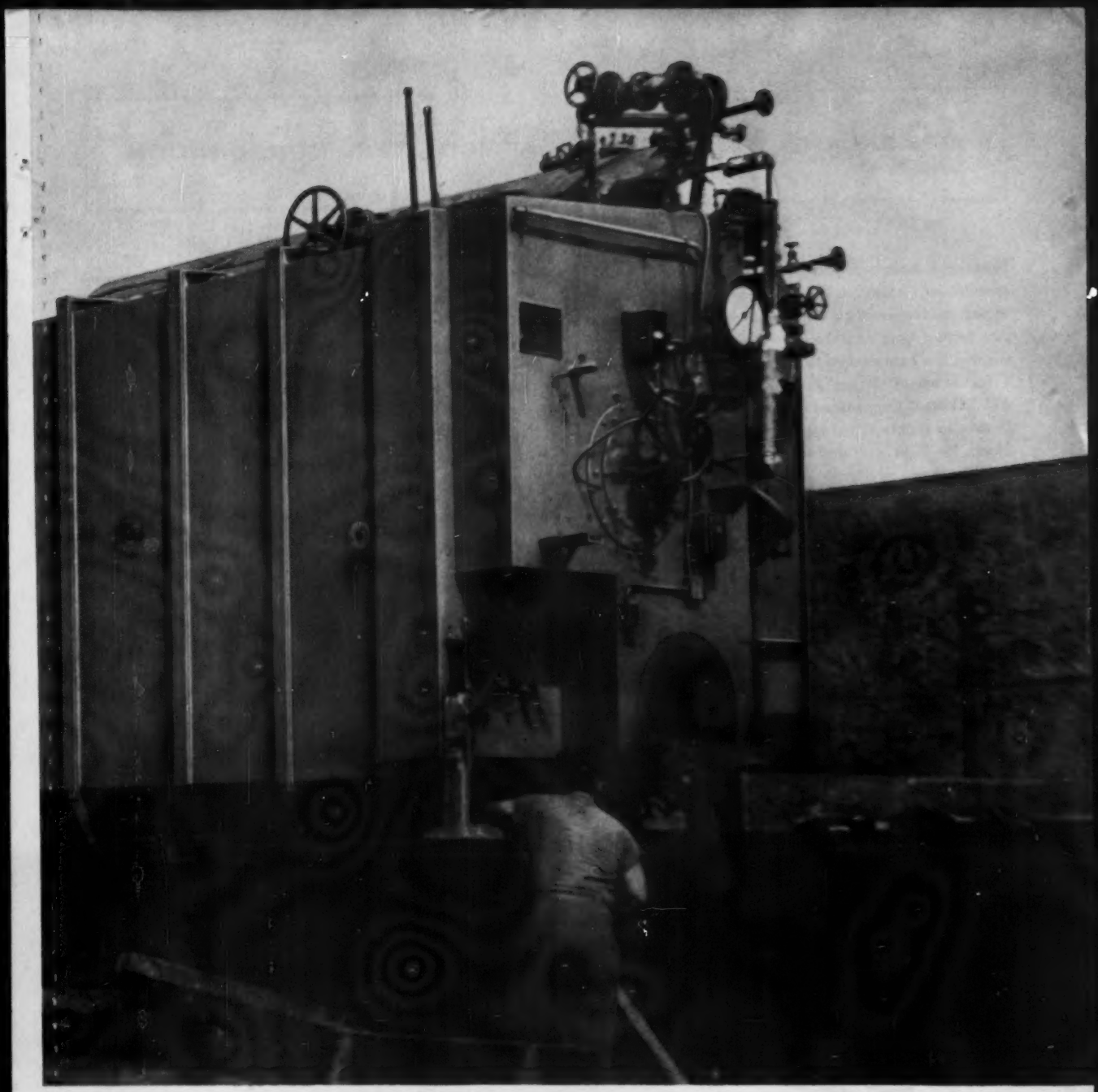




Number 1 of Nearly 1,000 Similar Units Meets Expanding Steam Requirements of Mexican Textile Firm

A decade ago, a major cleaning and laundering concern in Staten Island, N. Y., needed a dependable supply of steam for their massive laundering operation. In filling that need, B&W designed and delivered its first shop-assembled boiler. Operating at 165 psi and 358 F, this oil-fired package boiler served the company to perfection with 20,000 lb of clean, dry steam per hour.

The Staten Island firm had continuing success with this new departure in boiler design and in less than two years, the unit had paid for itself. The recent advent of the automatic washer and dryer, however, has so changed the laundry business that the firm now finds itself predominantly a dry-



cleaning establishment. Having no further need for a unit as large as the FM-type boiler, the original owner recently sold it (at a good percentage of its original cost) to another B&W customer, the Textiles y Acabades Company of Mexico. Today, the boiler continues its fine record, generating heat and process steam for the Mexican textile firm.

Indicative of the *built-in* durability of B&W units, the "times and travels of FM-1" are further evidence in action of dependable steam generation by B&W. Whatever *your* steam requirement . . . whatever your most economical fuel, B&W has the boiler best suited to your application. Your local B&W representative has all the facts on your area. Call him soon. The Babcock & Wilcox Company, Boiler Division, Barberton, Ohio.

B&W—THE NATION'S LEADING MANUFACTURER OF INDUSTRIAL BOILERS

G-980-18

B&W

THE BABCOCK & WILCOX COMPANY

BOILER DIVISION

For more facts circle 205 on Reader Service card, p 103

AT ASHLAND, KY. WORKS OF ARMCO STEEL CORPORATION

"Increased boiler capacity can often be obtained by modernizing boiler cleaning equipment. Another benefit of such modernization is more efficient utilization of the fuel . . . getting more heat into the steam for useful work and wasting less heat up the stack.

For example, at the Ashland, Kentucky Works of the ARMCO Steel Corporation there are four boilers that were unable to supply the growing steam requirements of the plant. The high exit gas temperatures suggested that a study be made to determine whether the cleaning could be improved to provide additional capacity. This study indicated that more steam from the same fuel could be expected if high pressure long retractable blowers were used for cleaning instead of the rotary blowers with which the boilers were originally equipped.

The expected results seemed sufficiently promising and it was decided to modernize the cleaning equipment of one boiler. The seven rotary blowers were replaced with four Diamond Long Retracting Blowers, one of which is shown below. This modernization proved to be justified as the boiler's maximum steam output was increased 11% and the exit gas temperature was reduced approximately 100° F.

A "Boiler Cleaning Modernization Program" is well worth careful consideration because it can mean substantial savings in so many ways. In addition to increased capacity and more efficient fuel utilization, there is reduced maintenance . . . also reduced operating costs when motorized units and automatic operation are installed. Even though your boiler cleaning was the best at the time it was installed, improvements since then will probably pay off. For many years Diamond has been doing continuous research to improve boiler cleaning and boiler cleaning equipment.

Ask the nearest Diamond office (or write directly to Lancaster) to make a study of your boiler cleaning . . . the possible savings may surprise you."

DIAMOND POWER SPECIALTY CORPORATION

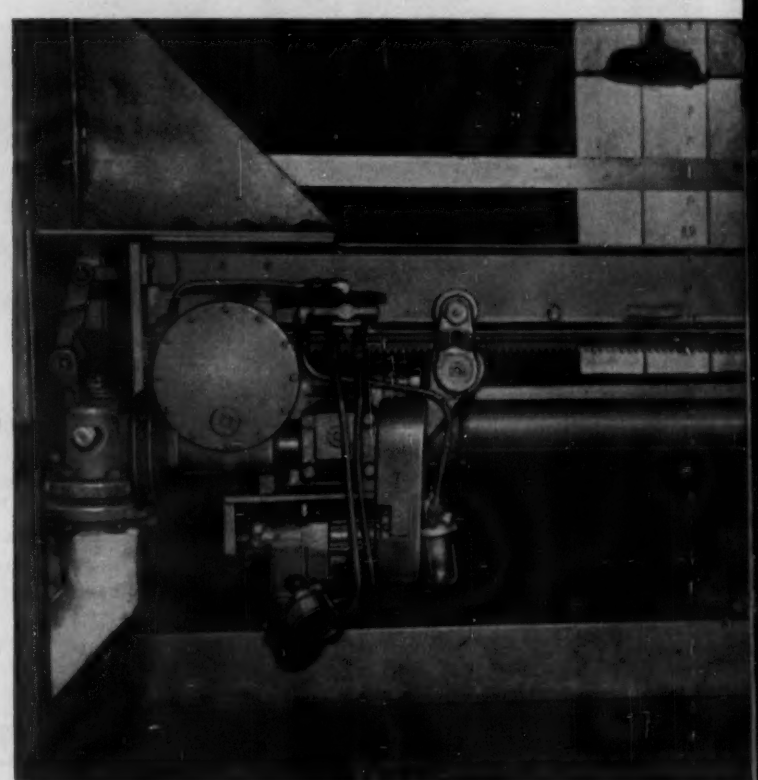
LANCASTER, OHIO

DIAMOND SPECIALTY LIMITED • WINDSOR, ONTARIO

The Mark of

BETTER BOILER CLEANING

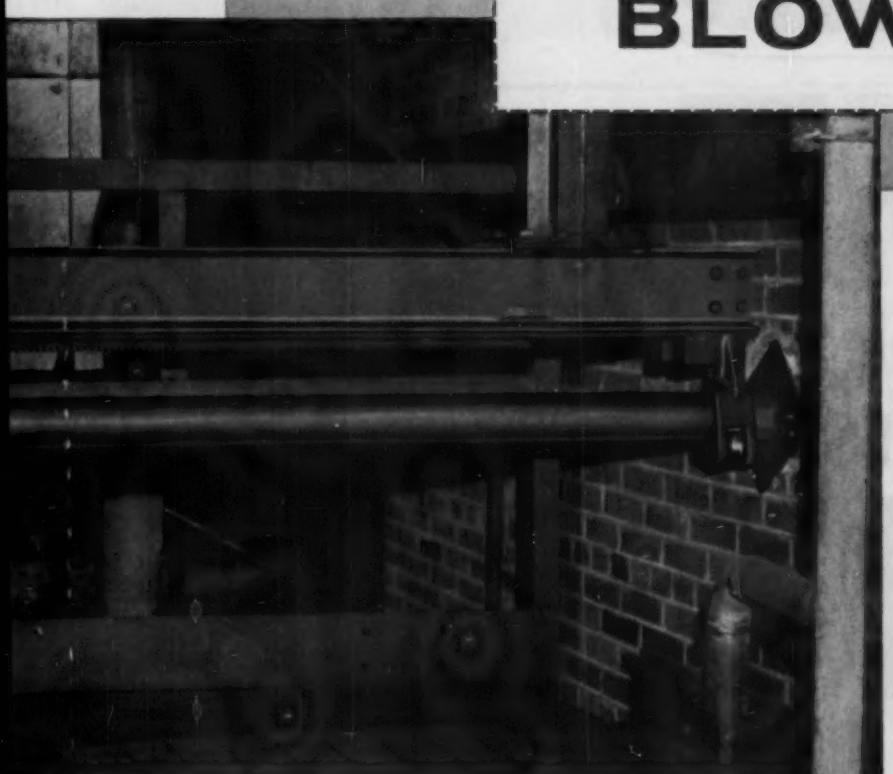
AT LOWER COST



11% More Steam 100° F Lower Exit Gas Temperature

RESULT FROM BOILER CLEANING MODERNIZATION PROGRAM

Using DIAMOND LONG RETRACTING BLOWERS



One of the four Diamond Long Retracting Blowers used to modernize the cleaning of the first boiler at the Ashland Works of ARMCO Steel Corporation. The results were so satisfactory that the three other boilers in this plant are now also being modernized.

8257

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MISSING!

5!

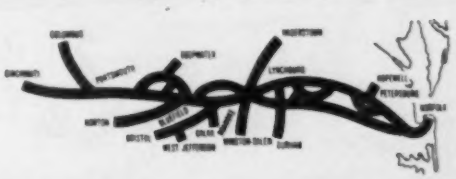
FIVE OF OUR LOCOMOTIVES ARE MISSING!

This time last year it took 8 hard-driving diesel locomotives . . . 5 on the head-end and a 3-unit pusher . . . to move a 150-car N&W coal train over the Blue Ridge.

It's a different story today! Now 200 — not 150 — N&W loaded cars are hustled over the mountains by just 3 diesel units! Thanks to the Virginian – N&W merger and new easier grades, each locomotive has a 324% increase in tonnage rating!

And that's not all. Use of new easier grades over the Alleghenies will permit movement of 77% more tonnage over these mountains with the same motive power as in the past.

Better grades, plus the largest fleet of coal-carrying hoppers, move your coal faster and more efficiently on the nation's going-est railroad! Get the full story from any N&W coal traffic representative.



Norfolk and Western
RAILWAY

GENERAL OFFICES • ROANOKE, VIRGINIA

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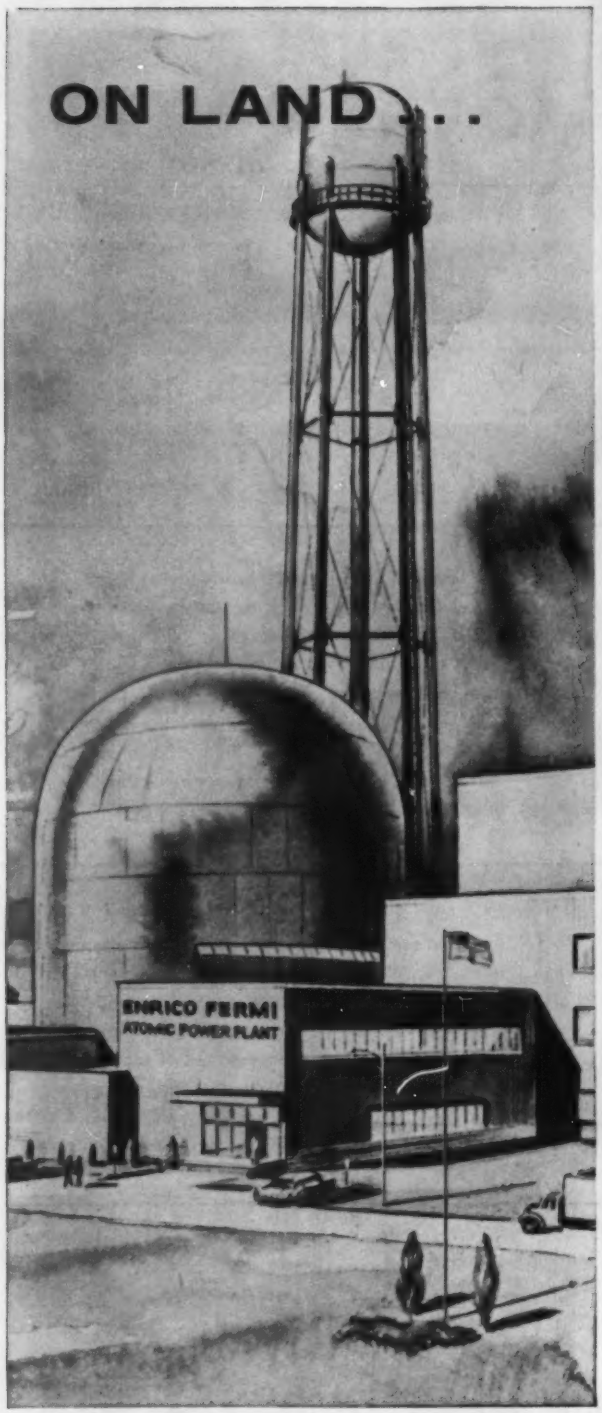
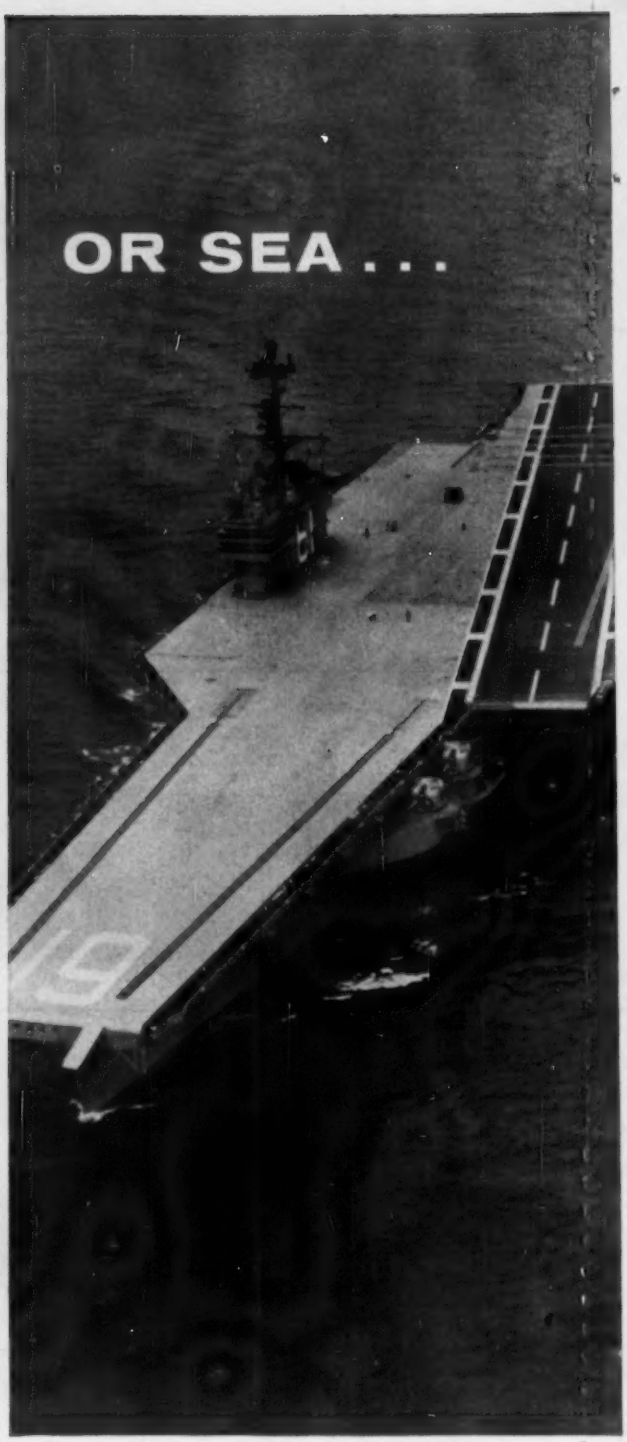


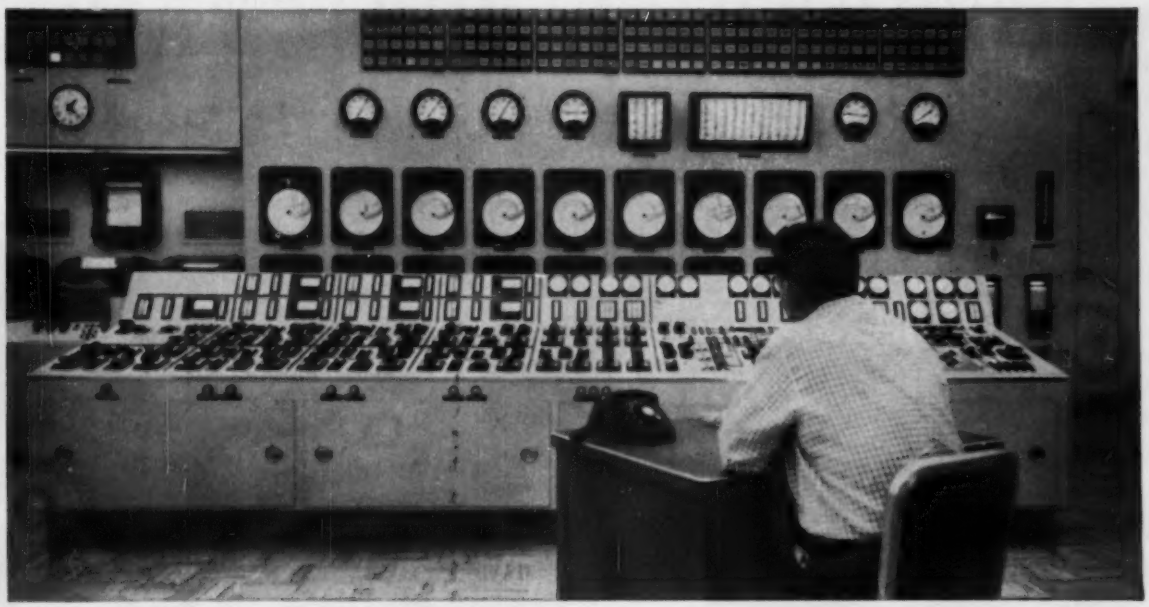
At the Enrico Fermi Atomic Power Plant, instruments and controls for both the "fast neutron breeder" reactor and the steam plant which it will "fire" are being furnished by Bailey.



Many of the new ships such as this super-carrier, USS Ranger, operate their boilers by Bailey Meter Control. Cargo ships, tankers, and passenger liners as well as Naval ships improve the economy and safety of their steam plants thru use of Bailey controls.

At the Thomas H. Allen Electric Generating Station of the City of Memphis, Tenn., Bailey operating indicators and controls for combustion, feed water, and steam temperature are centralized on the mechanical bench-board directly ahead, while the operating records which reflect trends are mounted on the vertical boards. A Bailey METROTYPE Information System, center left in the photo, scans, monitors, and logs functions usually assigned to strip-chart recorders.

IT'S BAILEY. . .



for the latest and safest instruments and controls for nuclear and conventional power plants!

Many of the power plants of the future will have controls and instruments designed and built by Bailey. There are two reasons: Bailey's continuing research and development toward the latest equipment for industry's needs; Bailey's 40-year association with the hardware and economic requirements of the industry.

If you are planning new or improved power plant facilities, call on Bailey engineers to assure that your system will have the *proper balance both as to economics and needs . . . that there will not be the unnecessary expense of over-instrumentation or control . . . nor the duplication of equipment functions.*

Call on Bailey for primary sensing devices, indicators, loggers, control units, panels, data handling equipment, computers for performance analysis, and supervisory controls. You'll find designs ranging from conventional to the most sophisticated . . . mechanical, pneumatic, electric and electronic, including solid state.

There's a Bailey District Office or Resident Engineer close to you. Check your phone book, or write direct.

A144-2

Instruments and controls for power and process

BAILEY METER COMPANY

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In Canada—Bailey Meter Company Limited, Montreal

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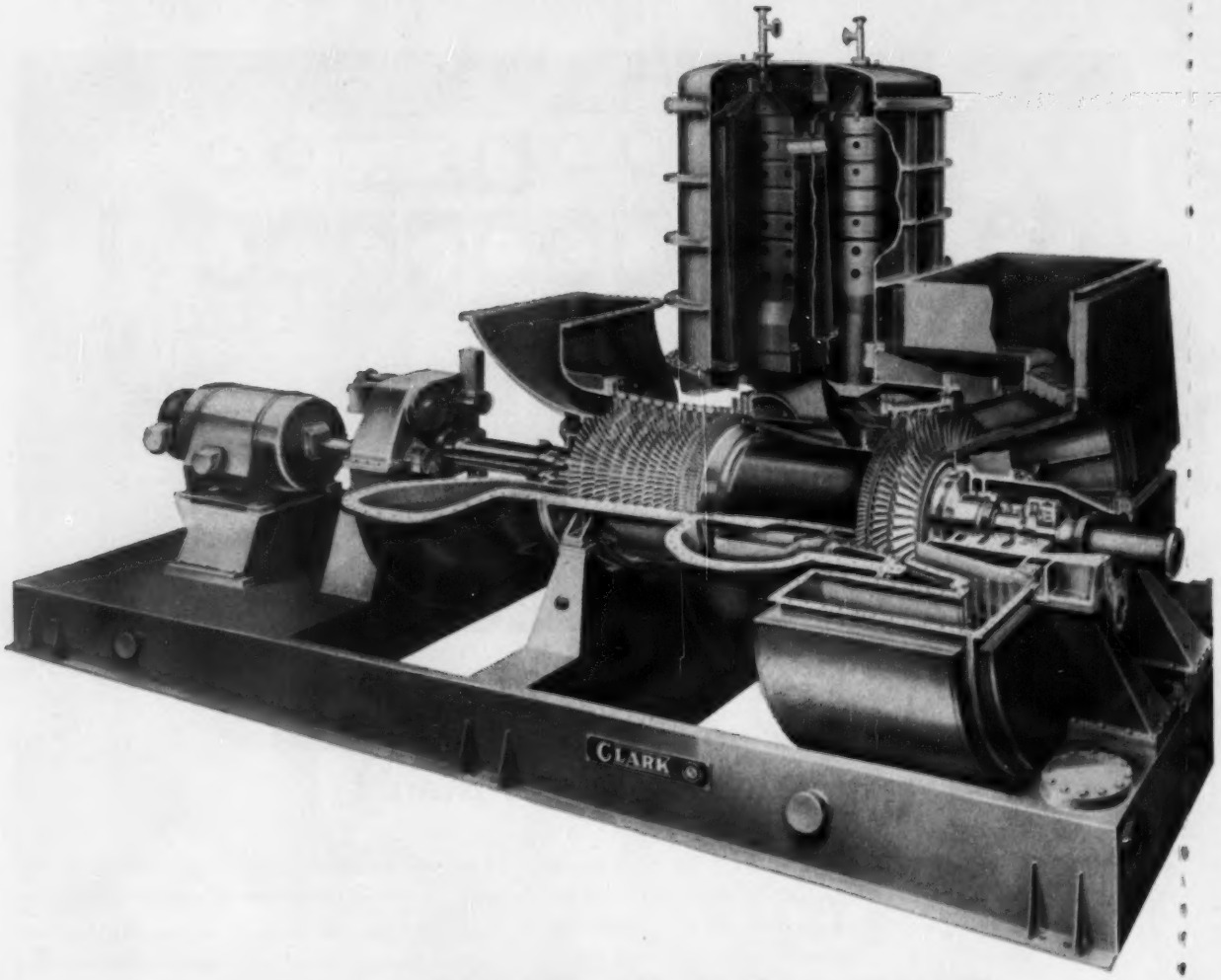
No matter how you gauge PRIME MOVER COST...



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ENGINES • GAS TURBINES • COMPRESSORS

the CLARK 300 series of GAS TURBINES measures up fully to your needs

Name the norm . . . capital investment, floor space, installation or operating labor, general reliability, maintenance or all combined. Whatever you use to determine *real* prime mover cost, Clark heavy duty industrial gas turbines provide the most economical answer to your requirements. As an example of how these advantages work for you let us examine the latest addition to the Clark 300 series of turbines, the Model 305-S.

CONSIDER INITIAL INVESTMENT—This single-shaft open cycle machine is simplicity itself. With the axial compressor and three stage turbine mounted on the same shaft, parts . . . *and cost* are cut to a minimum.

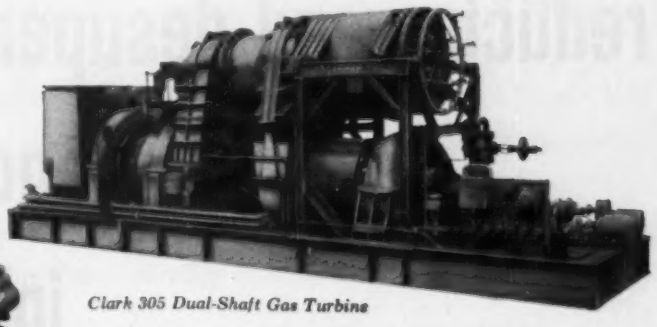
FIELD PROVED RELIABILITY—Important components such as compressor and turbine blading are based on proved designs which have operated for thousands of hours in Clark Dual-Shaft Gas Turbines. Turbine inlet temperature is held under 1400° F to ensure extra long life and to provide a substantial margin of operating safety. The turbine is completely air cooled and suitable for operation in arid country. Pressurized air is bled off the axial compressor to cool turbine blade roots and other high temperature components. In addition, cool air envelopes between inner and outer skin surfaces reduce heat loss and minimize heat radiation.

FLOOR SPACE INSTALLATION AND MAINTENANCE—The Clark 305-S is so compact it is mounted on a skid only 26 feet long. The combustion chamber with two parallel burners is placed over the rotor between compressor and turbine. You save on floor space, housing, transportation to the site, foundation and installation expense. Both the single and dual-shaft Clark gas turbine designs have provisions for easy access to blading, bearings and seals for inspection or maintenance.

VERSATILE TOO—Clark Series 300 Gas Turbines in the 8000-10,000 horsepower class provide the inherent flexibility to match the application. The dual-shaft models are excellent drivers for pumps or compressors on liquid or gas transmission lines, for marine propulsion, compressor drivers in repressuring or process plants and other uses requiring broad speed and loading flexibility. For applications that do not require the wide range flexibility of the dual-shaft machine such as base load or peaking turbogenerators the single-shaft units are ideal. Both designs burn either liquid or gaseous fuels.

Your Clark representative will gladly give you all of the cost saving details on Clark Gas Turbines. Consult him or write us direct. CLARK BROS. CO., OLEAN, NEW YORK.

Clark 305-S Single-Shaft Gas Turbine



Clark 305 Dual-Shaft Gas Turbine

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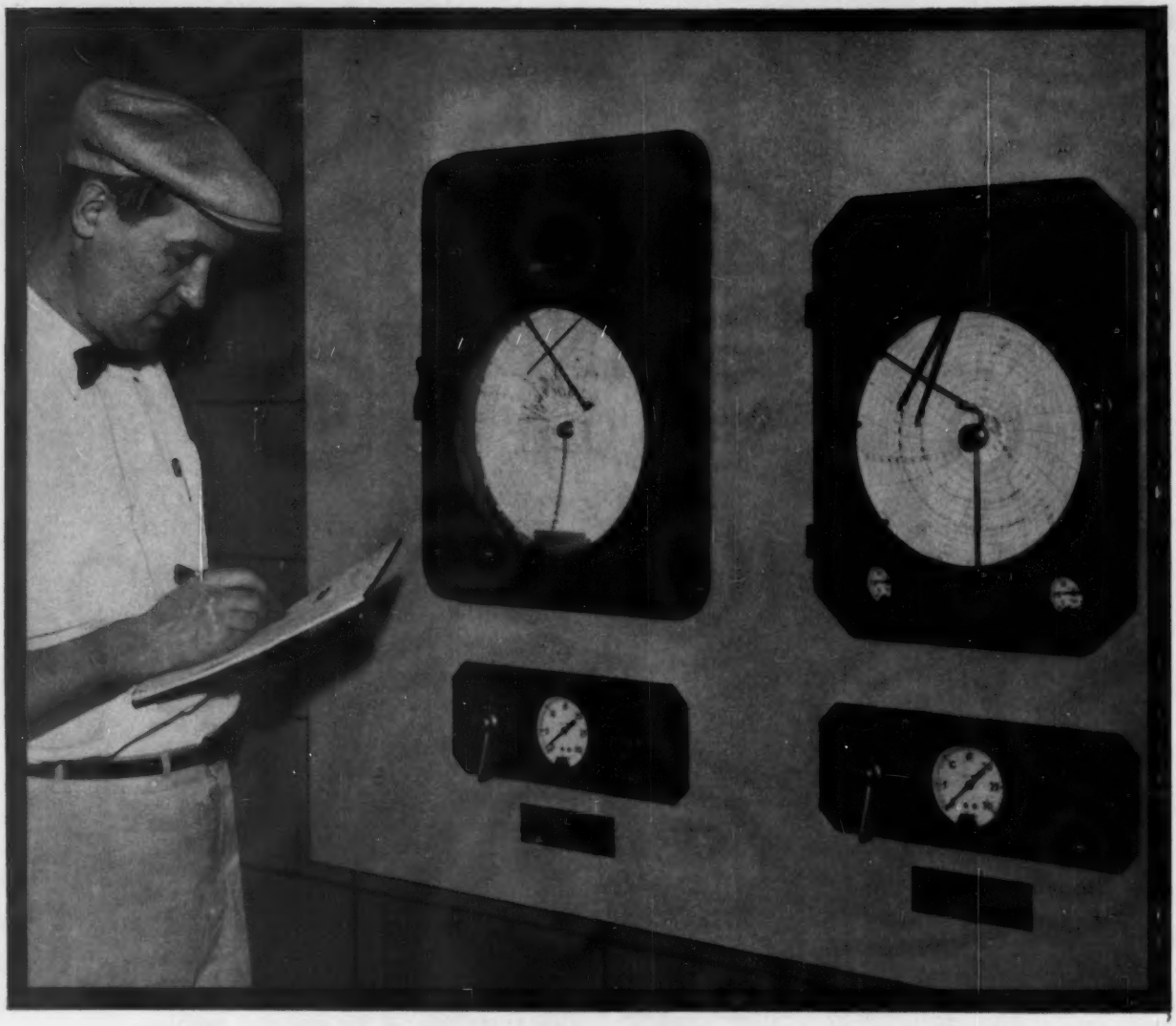
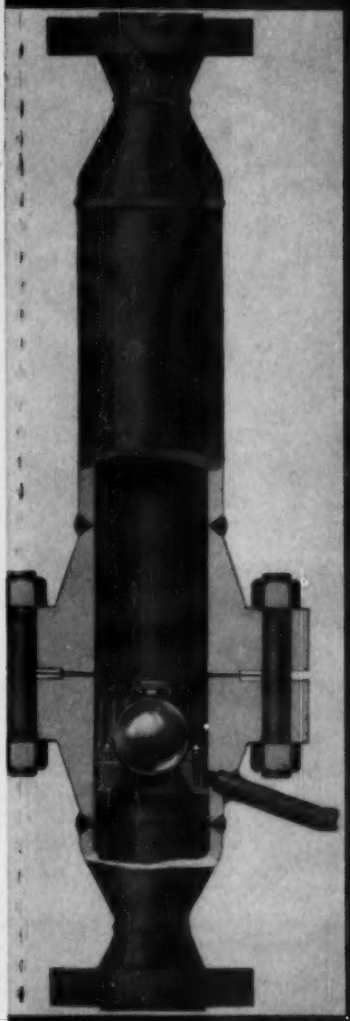


H. J. Heinz relies on Copes-Vulcan reducing and desuperheating station to handle big changes in steam demand



(Far left) **Chart on left side of panel** shows wide load changes. Chart on right indicates exacting pressure and temperature control. Station takes boiler steam at 600 psig and 750 degrees F. and delivers it to process at 110 psig and 360 degrees F.

(Cutaway at left) **A weighted steel** ball controls orifice opening, speeds intimate mixing of cooling-water and steam. No atomizing steam, spray nozzle, or glands required. Write for Bulletin 1037.

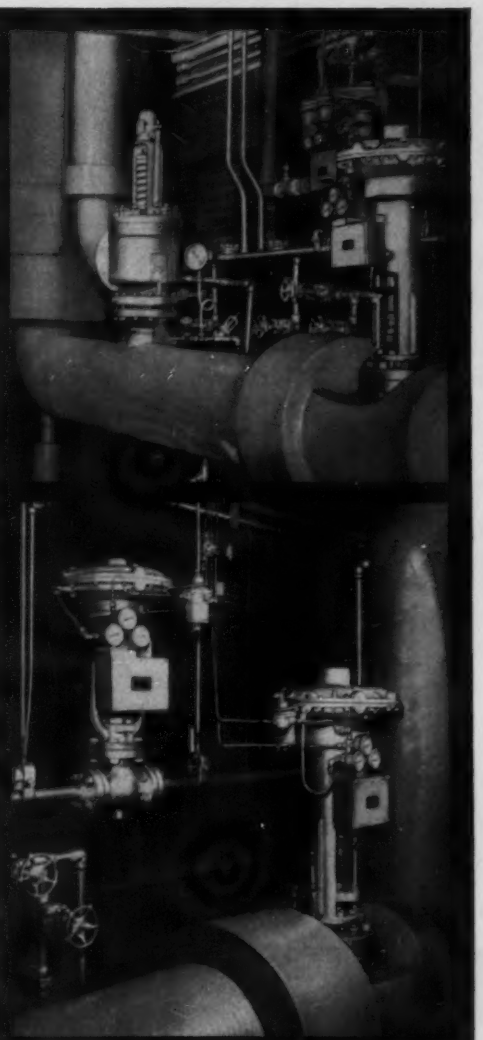
(Upper right) **The 8-inch, 300-pound pressure desuperheater** is installed in the insulated vertical run of steam piping at the far left. The cooling-water control valve is behind the pressure reducing valve in the right foreground.

Fast acting valves assure rigid control

Cooling water flow for the desuperheater is controlled by a 1-inch, 300-pound standard Type CV-D diaphragm valve (left) actuated by a temperature controller.

The 600-pound standard Type CV-D reducing valve (right) has a 4-inch inlet and 8-inch outlet to take care of steam expansion at reduced pressure. Its positioner assures accurate control modulation.

Copes-Vulcan diaphragm type valves can be direct or reverse acting. Piston types are also available for high duty service, assure maximum power with precise positioning. Write for Bulletin 1027.



Working with flow rates that vary from 0 to 70,000 pounds per hour, this Copes-Vulcan reducing and desuperheating station holds process steam to plus-or-minus 4 psig and plus-or-minus 5 degrees F. with only 16 degrees F. superheat. Wide fluctuations in steam requirements often occur extremely rapidly at the H. J. Heinz plant in Pittsburgh. On a typical day, the load increased from 0 to 47,000 pounds per hour within 15 minutes, then dropped back to 5,000 pounds per hour in even less time.

Made up of a Copes-Vulcan Variable-Orifice desuperheater and diaphragm operated Type CV-D valve, this type of station represents a new approach in process steam control. Since its installation over a year ago, the station has maintained an outstanding record for continuous accuracy.

Whatever your operating conditions, Copes-Vulcan has the desuperheating station for controlling your reduced steam temperatures. Besides the Variable-Orifice type, the line includes a Steam-Assist type and a Carburetor type. Write for details.

Copes-Vulcan Division, Erie 4, Pennsylvania.

Copes-Vulcan Division

BLAW-KNOX

For more facts circle 210 on Reader Service card, p 103

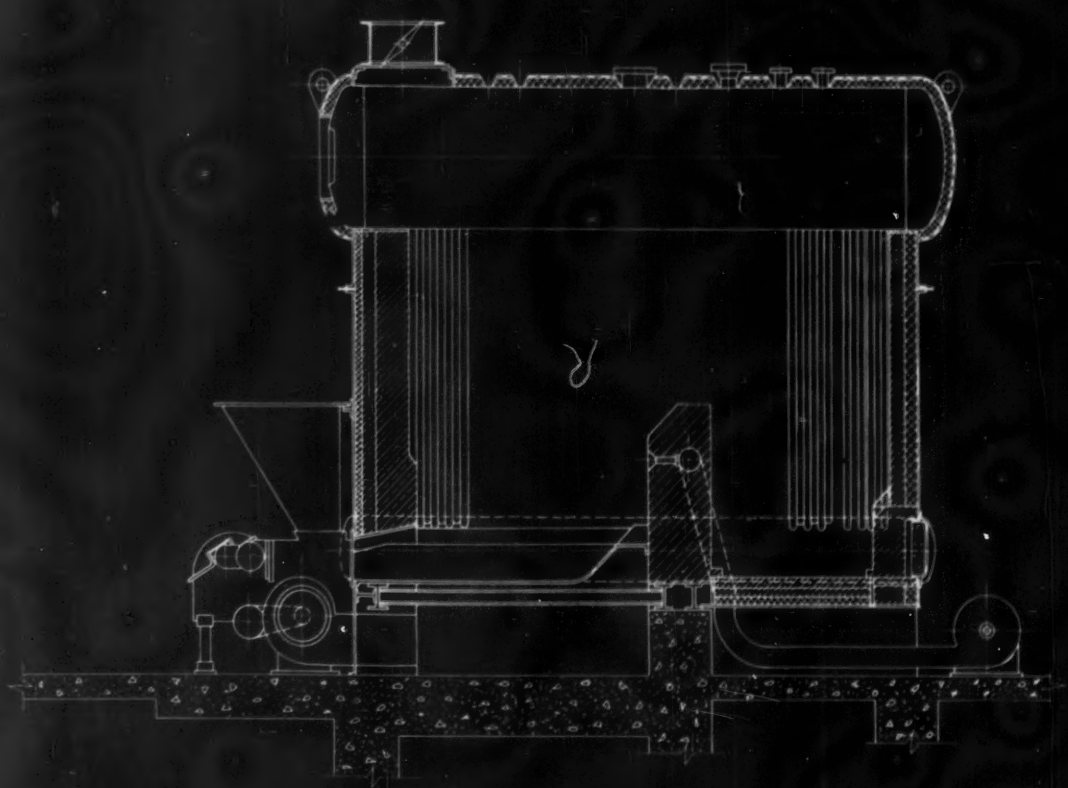
you can take full advantage of the fuel situation with

WICKES

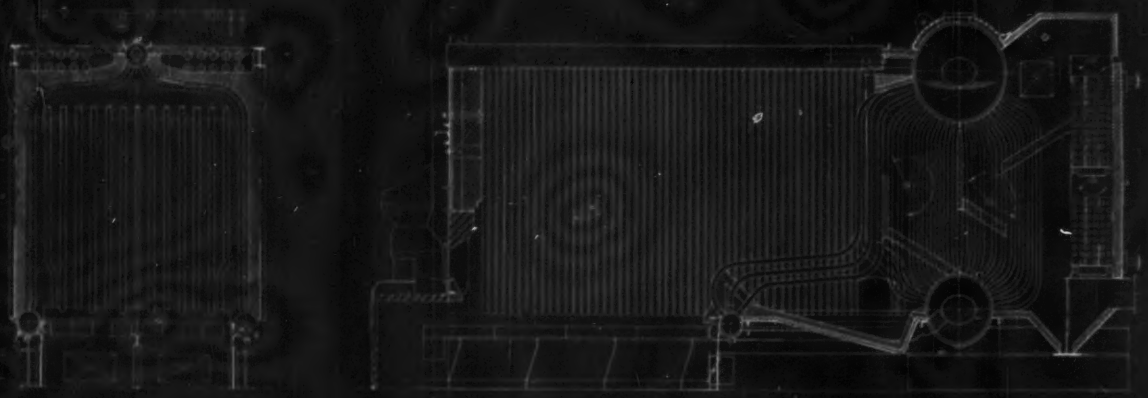
PACKAGE STOKER-FIRED STEAM GENERATORS

Designed and built to WICKES recognized standard of excellence, engineered to WICKES high standard of efficiency

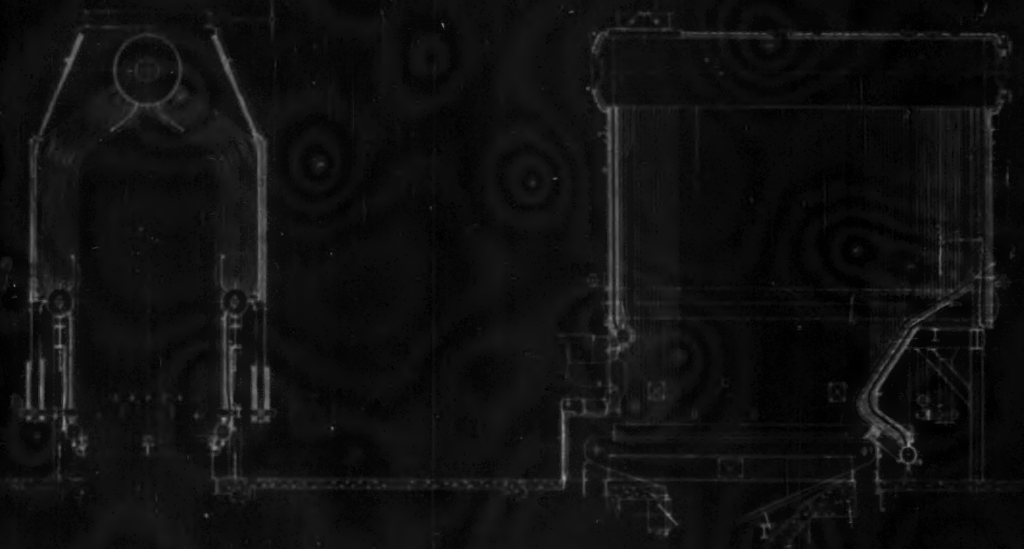
These stoker-fired WICKES generators are compact, package water tube boilers, custom-engineered to your exact steam generating requirements. Semi-automatic in operation and convertible from stoker-fired to either gas or oil fired, these WICKES generators are built to the highest standards of workmanship to give you the same efficiency of operation that you have come to expect from all WICKES-built boilers. They are built in a variety of designs to meet size, space and fuel conditions. For complete information on these WICKES stoker-fired units as well as the complete line of WICKES water tube steam generators, ask the WICKES sales representative nearest you to call . . . offices in principal cities*.



TYPE A



TYPE S-3



TYPE A

WICKES

BOILER CO., SAGINAW 10, MICHIGAN

DIVISION OF THE WICKES CORPORATION

RECOGNIZED QUALITY SINCE 1854

*SALES OFFICES: Atlanta • Boston • Charlotte, N. C. • Chicago • Cleveland Dallas • Denver • Detroit • Houston • Indianapolis • Los Angeles • Memphis Milwaukee • New Orleans • New York City • Philadelphia • Portland, Ore. Rochester, N. Y. • Saginaw • San Francisco • Seattle, Wash. • Springfield, Ill. • Tulsa

For more facts circle 211 on Reader Service card, p 103

WHERE DO YOU STAND ON BOILER

TYPICAL USERS OF YARWAY INDICATORS FROM OVER 15,000 INSTALLATIONS

INDUSTRIAL PLANTS

WEYERHAEUSER COMPANY
REPUBLIC STEEL CORP.
FORD MOTOR COMPANY
UNION BAG & PAPER COMPANY
WESTINGHOUSE ELECTRIC CORP.
GENERAL ELECTRIC COMPANY
STAUFFER CHEMICAL COMPANY
WILSON & COMPANY
U. S. STEEL COMPANY
GENERAL MOTORS
MOBIL OIL COMPANY

UTILITIES

(Code Case #1155 Installations)

COMMONWEALTH EDISON
IOWA ILLINOIS GAS & ELECTRIC
CENTRAL ILLINOIS PUBLIC SERVICE
ILLINOIS POWER CO.
WISCONSIN POWER & LIGHT
LAKE SUPERIOR DISTRICT POWER
NORTHERN STATES POWER CO.
PUBLIC SERVICE OF INDIANA
INDIANAPOLIS POWER & LIGHT
IOWA ELECTRIC LIGHT & POWER
NEBRASKA POWER
NEW ENGLAND POWER
ROCHESTER GAS & ELECTRIC CO.
PENNSYLVANIA ELECTRIC CO. (ERIE, PA.)
OMAHA PUBLIC SERVICE
CENTRAL ILLINOIS ELECTRIC
NARRAGANSETT ELECTRIC CO
LOUISIANA POWER & LIGHT
HARTFORD ELECTRIC LIGHT CO.
POTOMAC ELECTRIC POWER CO.

WATER LEVEL INDICATION ?

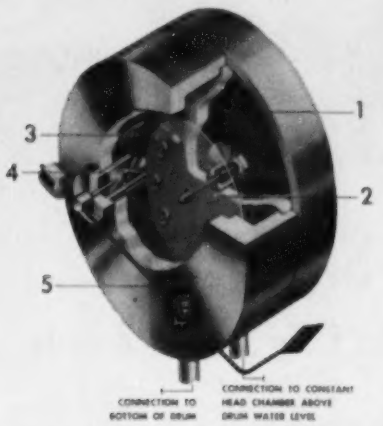
YARWAY REMOTE INDICATORS HAVE BRILLIANT "WIDE ANGLE" VISIBILITY... CAN BE INSTANTLY READ FROM MULTIPLE VANTAGE POINTS

Yarway Remote Liquid Level Indicators bring distant, often hard-to-see boiler level readings right down to eye level on the panel board or other convenient location.

No matter where you stand—at any point in a 180° arc, and from a considerable distance—the brilliant new wide vision dial makes viewing and reading easy.

GIVE INSTANT, ACCURATE READINGS BECAUSE INDICATOR IS OPERATED BY THE BOILER WATER ITSELF

Remote readings of levels in boilers (also feed water heaters and other heat exchangers) are instant and accurate because indicator *operating mechanism* is actuated by the varying head of the liquid itself, yet the *pointer mechanism* is never under pressure.



Constant pressure from a controlled-temperature constant head chamber located above drum level is maintained on one side of diaphragm (1) in indicator. Varying pressure changing with water level is maintained on opposite side of diaphragm. Change in differential between the two pressures moves the diaphragm which in turn regulates, through deflection plate (2), magnet (3), and spiral magnetic armature (4), the position of the counterbalanced pointer (5).

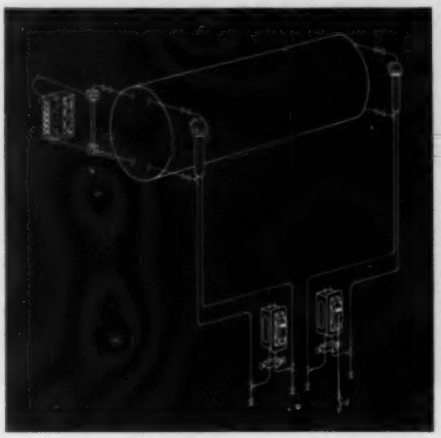
OPERATE ADDITIONAL REMOTE SIGNAL ALARMS, HORNS OR LIGHTS

With the addition of a control unit Yarway Indicators may be equipped to operate auxiliary hi-lo signal alarms, horns or lights located at any place in the plant. Electronic secondary indicators may also be used to duplicate readings at remote points.

FULLY APPROVED AS PRIMARY INDICATING ELEMENTS UNDER BOILER CODE CASE #1155

Under A.S.M.E. Boiler Code Committee ruling in Case #1155, two independent remote level indicators of compensated manometric type may be used instead of one of two required gage glasses for boiler pressures 900 psi and above. When both indicators are in operation, the gage glass may be shut off but shall be maintained in serviceable condition.

Yarway Remote Liquid Level Indicators conform to this ruling and are used widely for primary boiler water level indication in plants operating at 900 psi and above.



All Yarway Indicators for service over 700 psi are temperature-compensated; pressure compensation available when desired. Use of controlled-temperature column on constant head chamber fully protects against system upsets.

If you would like a reprint of this Boiler Code ruling, just ask for Case #1155 reprint.

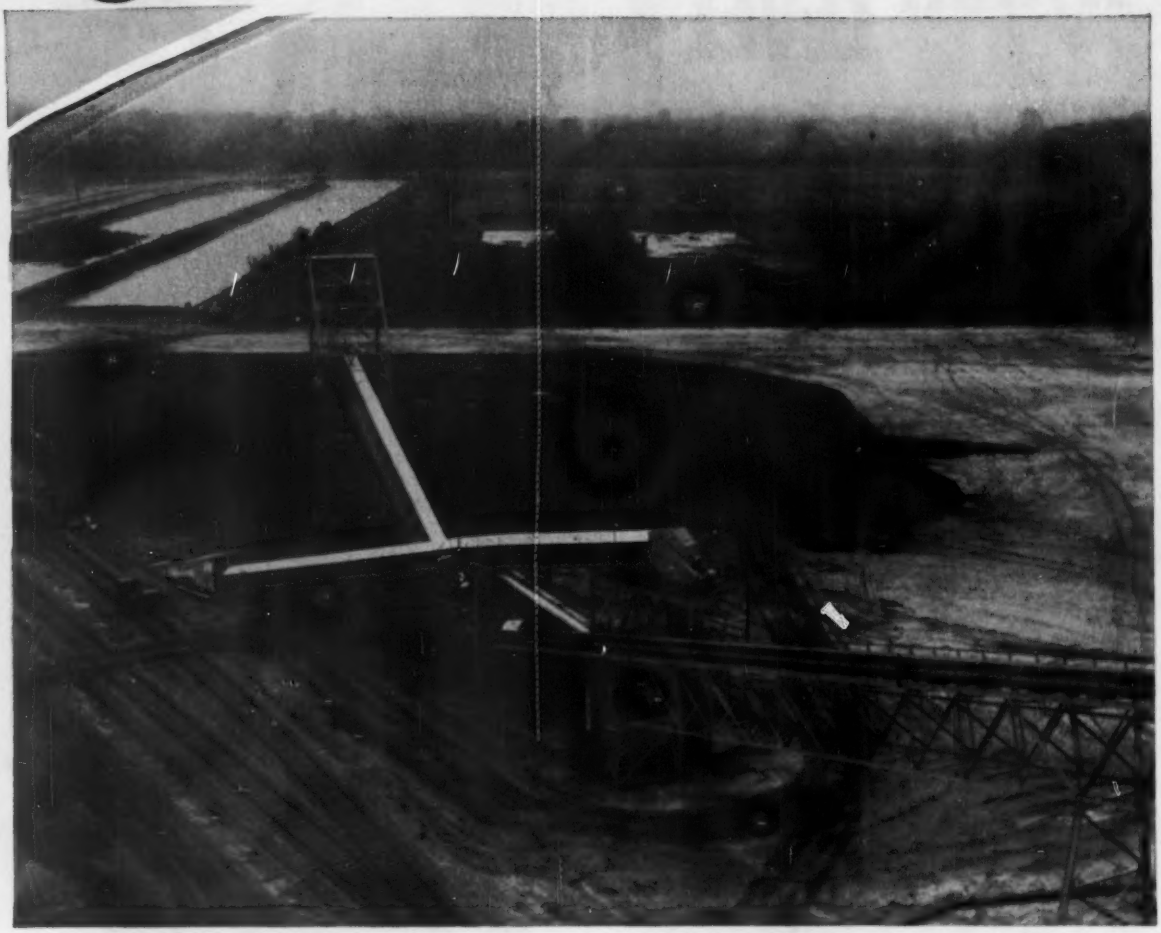
Get the full story on Yarway Liquid Level Indication for your plant. Write for new 24-page Bulletin WG-1825.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY
A MARK OF QUALITY IN STEAM ENGINEERING

For more facts circle 212 on Reader Service card, p 103

US RUBBER CONVEYOR BELTS



COAL COMES BACK TO SAVANNAH...

Substantial Savings Experienced..."U.S." Belts are used exclusively

Now more economical and accessible than other fuels, coal is being used to produce power in Savannah, Georgia, at the new Port Wentworth Power Station of Savannah Electric and Power Company. The 55,000 kilowatt unit was placed in operation midway in 1958, and is one of the most efficient steam electric stations of its size in the country.

The plant was designed around the conveyor system in order to get the lowest cost coal handling with a minimum operating force. Coal is transferred from stockpile to station, a vertical lift of 104 feet to the hopper bin, by the exclusive use of U. S. Rubber Belts.

"U. S." Belting engineers, working closely with engineers of the conveyor system and of the utility, designed the belts for the system. It is designed to carry up to 500 tons an hour.

• • •

When you think of rubber, think of your "U. S." Distributor. He's your best on-the-spot source of technical aid, quick delivery and quality industrial rubber products.

Visit Booth No. 801, American Mining Congress

US RUBBER

Mechanical Goods Division

United States Rubber

WORLD'S LARGEST MANUFACTURER OF INDUSTRIAL RUBBER PRODUCTS

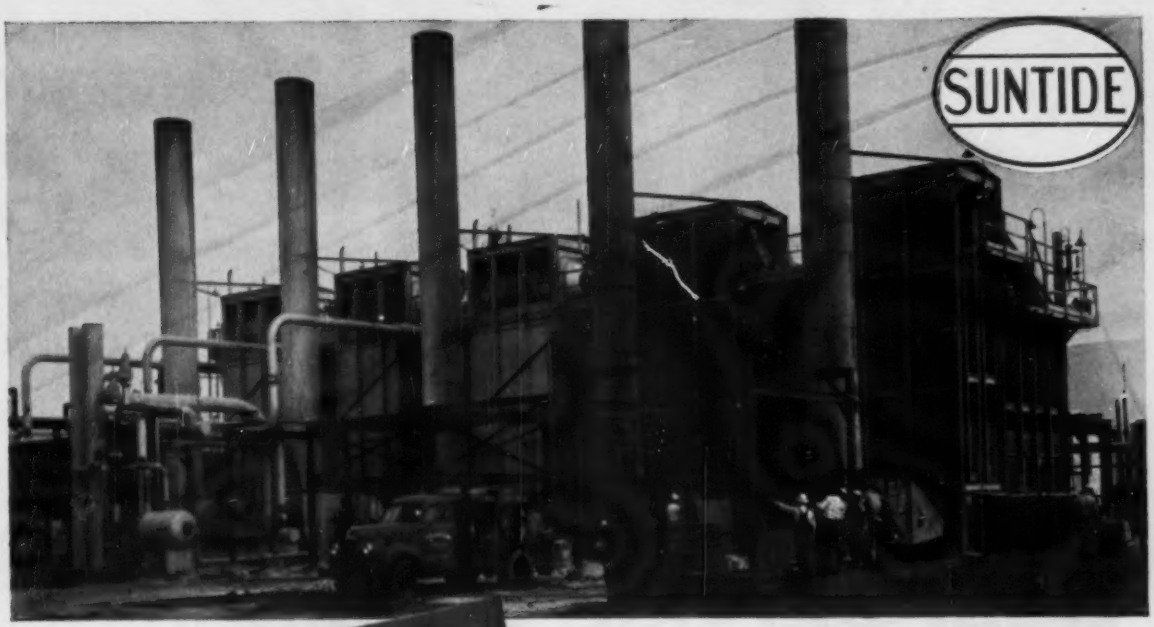
Rockefeller Center, New York 20, N.Y. In Canada: Dominion Rubber Company, Ltd.

For more facts circle 213 on Reader Service card, p 103

Vogt STEAM GENERATORS

at SUNTIDE REFINING COMPANY

Viola, Texas



Above: Cross Section showing arrangement of steam and water drums, tubes, baffles, and furnace.

6 EFFICIENT AND ECONOMICAL UNITS SERVE THIS MODERN REFINERY

Principle Data Each Unit

- 85,000 pounds steam per hour capacity, designed for 500 lbs. S.W.P. and 625° F. total temperature.
- Water cooled furnace.
- Burners for Gas and Oil fuel.

Vogt offers a complete line of custom built and package type steam generators. Available in bent tube and straight tube designs for solid, liquid, or gaseous fuels burned singly or in combination.

Write for bulletins. Dept. 24A-BP

OTHER VOGT PRODUCTS

Forged Steel Valves, Fittings and Flanges—Petroleum Refinery and Chemical Plant Equipment
Heat Exchangers
Ice Making and Refrigerating Equipment

HENRY VOGT MACHINE CO.

Box 1918, Louisville 1, Kentucky

SALES OFFICES: New York, Chicago, Cleveland, Dallas, Camden, N. J. St. Louis, Charleston, W. Va., Cincinnati, Los Angeles.

For more facts circle 214 on Reader Service card, p 103

SELECTIVITY CURVES *show tripping times for all breakers in your G-E Load Center—your assurance of SELECTIVE COORDINATION under all conditions. Ask for them.*

Selectively Coordinated Load Centers Deliver . . .

Best Service Continuity Under All Conditions

. . . Yet you pay no price premium if you buy from General Electric

SELECTIVE COORDINATION GIVES BEST SERVICE CONTINUITY

SELECTIVELY COORDINATED Load-Center Unit Substations are your best assurance of power continuity. Power circuit breakers are factory-preset by General Electric so that—during short-circuit conditions—only the circuit breaker on the faulted feeder opens. Power continues to flow through unfaulted circuits to the rest of the loads. This "selectivity" between main and feeder breakers is accomplished by coordinating the tripping time of the main and feeder breakers.

During any magnitude of feeder short circuit, the main breaker "waits" until the feeder breaker opens.

YOURS AT LOWER COST

You now can have this superior coordination at no extra cost. Advanced engineering techniques by General Electric have eliminated the price premium normally charged for this inherently higher cost, more highly-engineered unit substation. In addition, you can save by using manually operated, stored-energy breakers in place of electrical units which were formerly required.

This means that General Electric SELECTIVELY COORDINATED load centers are now available at the same price as the fully rated load centers.

ONLY CURVES PROVE YOU HAVE SELECTIVE COORDINATION

Specify the SELECTIVELY COORDINATED Load-Center Unit Substation, with coordination curves for the specific breakers in your Load Center. These curves will show you how time-current characteristics combine to assure you of maximum power service continuity.

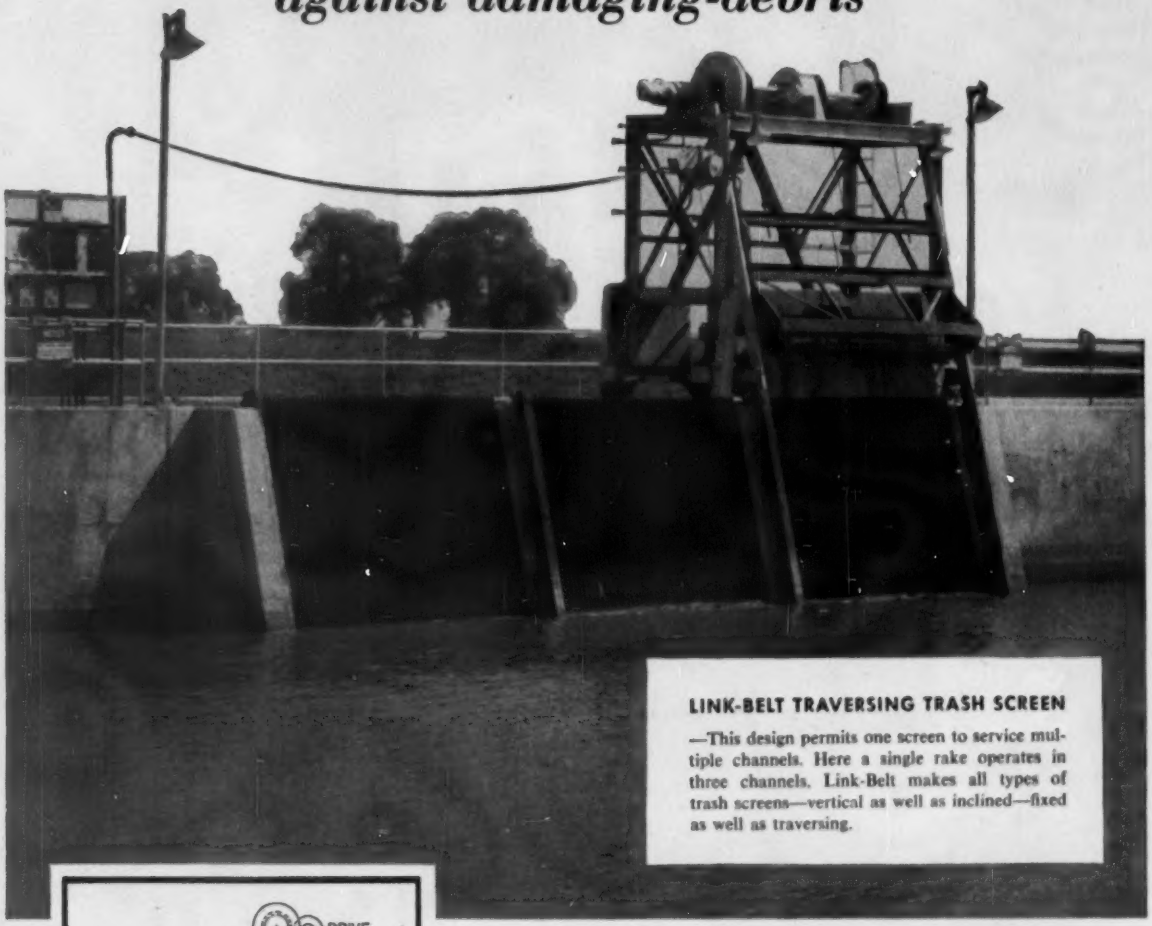
For more detailed information, contact your nearest General Electric Apparatus Sales Office, or write to General Electric Co., Schenectady 5, New York for publication GEA-3592. 533-02

Progress Is Our Most Important Product

GENERAL ELECTRIC

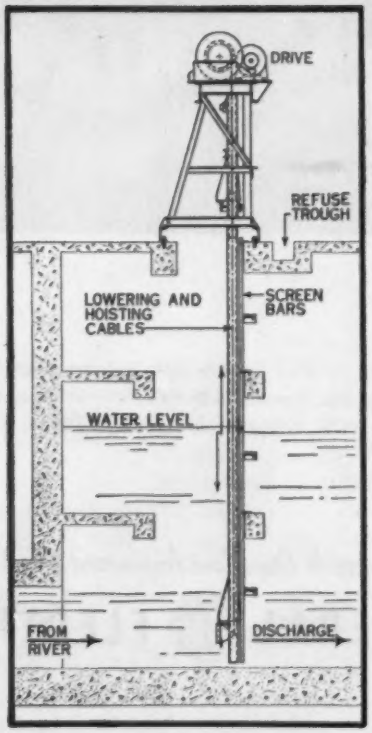
For more facts circle 215 on Reader Service card, p 103

ESSENTIAL SAFEGUARD
against damaging-debris



LINK-BELT TRAVERSING TRASH SCREEN

—This design permits one screen to service multiple channels. Here a single rake operates in three channels. Link-Belt makes all types of trash screens—vertical as well as inclined—fixed as well as traversing.



LINK-BELT trash screens provide economical, effective protection for pumps, turbines and screens.

Put a protective screen between vital equipment and destructive debris such as logs and ice. Link-Belt trash screens also reduce load on traveling water screens during heavy seasonal accumulations of leaves, Spanish moss, water hyacinths and algae.

These screens feature simple design, rugged construction. They require little attention—operation is necessary only when trash has accumulated. This is accomplished by merely pressing a button to actuate the motor-propelled rake. Refuse is then removed manually from the rake to a refuse trough. Intermittent operation keeps power costs down to a minimum.

And Link-Belt will work with your engineers and consultants in supplying whatever your plant requires in screening, coal handling and mechanical power transmission equipment. Get complete facts from your nearest Link-Belt office. Or write for Book 2587.

LINK-BELT

18,184

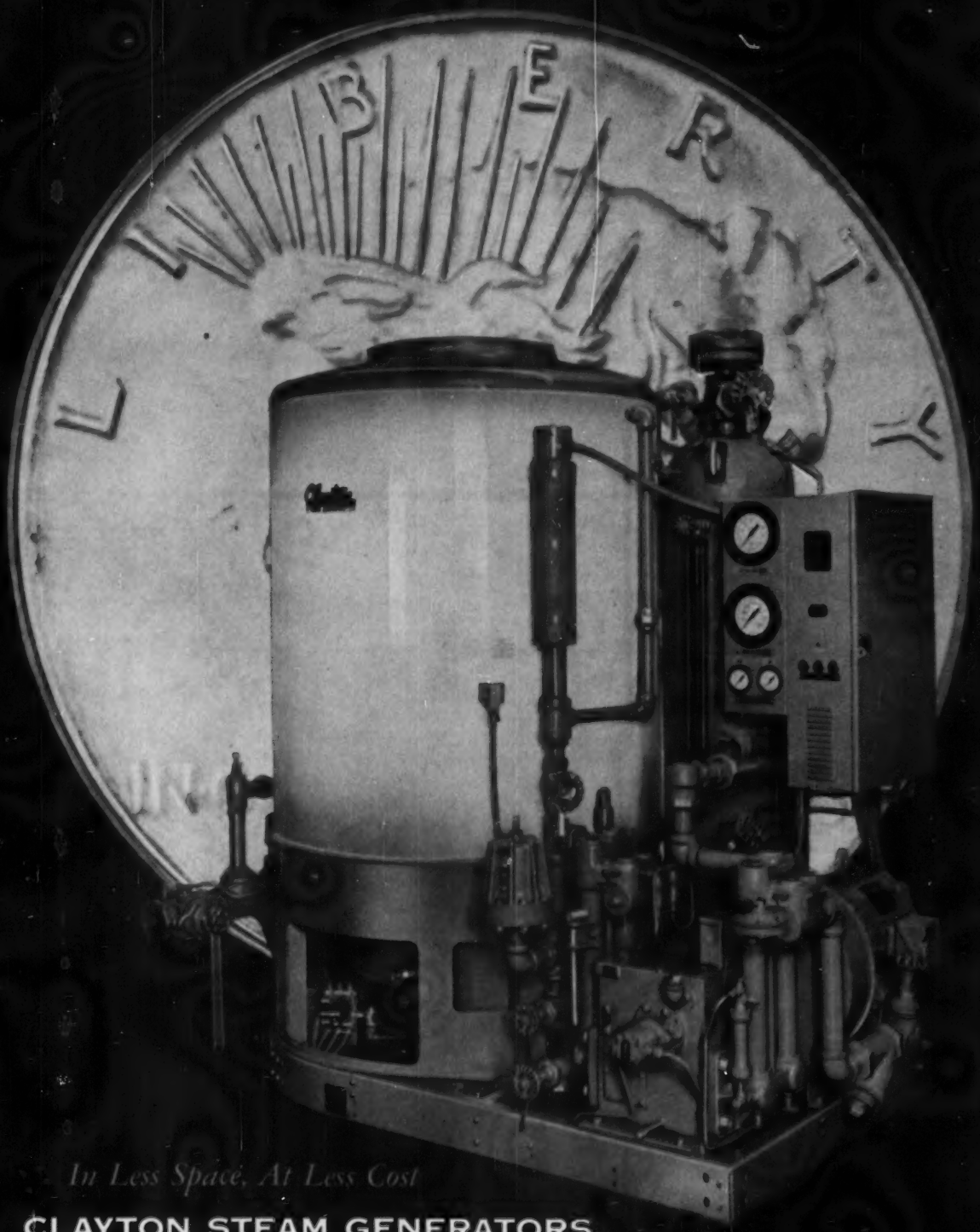
POWER PLANT EQUIPMENT

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Australia, Marrickville (Sydney); Brazil, Sao Paulo; Canada, Scarboro (Toronto 13); South Africa, Springs. Representatives Throughout the World.

For more facts circle 216 on Reader Service card, p 103

For more facts circle 217 on Reader Service card, p 103 ▶

STEAM THE MODERN WAY



In Less Space, At Less Cost

CLAYTON STEAM GENERATORS...

SAVE SPACE AND INSTALLATION COSTS—Only a fraction the size and weight of ordinary boilers. Models from 16½ to 175 HP. All sizes 65 to 195 psi. Larger sizes 15-295 psi.

SAVE ON STEAM—You pay only for the steam you use. Steam in 3 minutes or less from cold start—no standby loss.

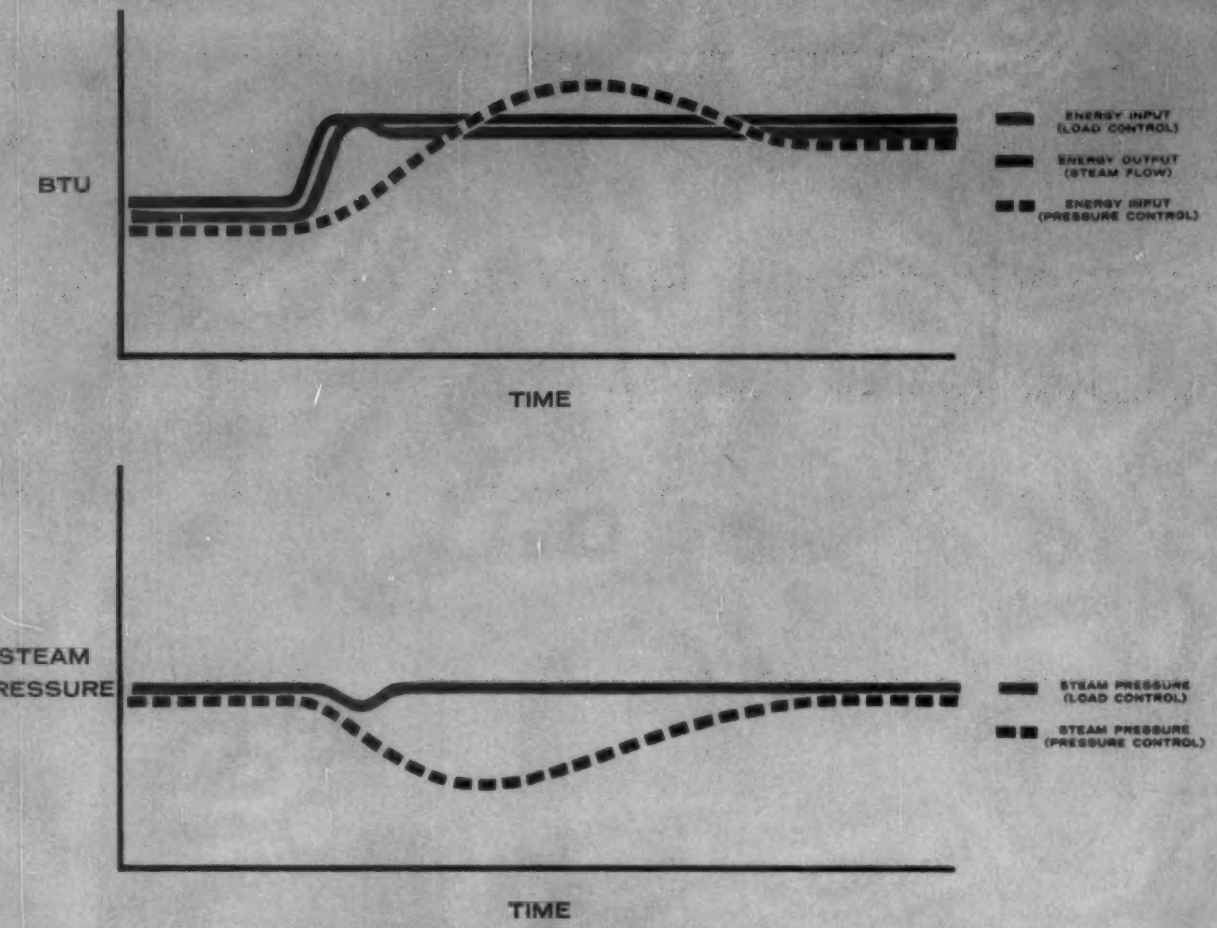
SAVE ON OPERATING COSTS—Cut fuel costs up to 50%, save labor, maintenance and time.

Write today for more complete information.

Clayton

416 MANUFACTURING COMPANY

EL MONTE, CALIFORNIA • CINCINNATI, OHIO



Republic's patented electronic load control system quickly establishes new firing condition and rate of feedwater flow. Note that steam pressure varies a relatively small amount and for a short interval. Electronic load control establishes new energy levels much faster than steam pressure control systems. This high speed control results in improved stability and safety. Steam pressure is more accurately controlled, and a more efficient fuel-air ratio is maintained.

Republic Electronic Load Control Gives

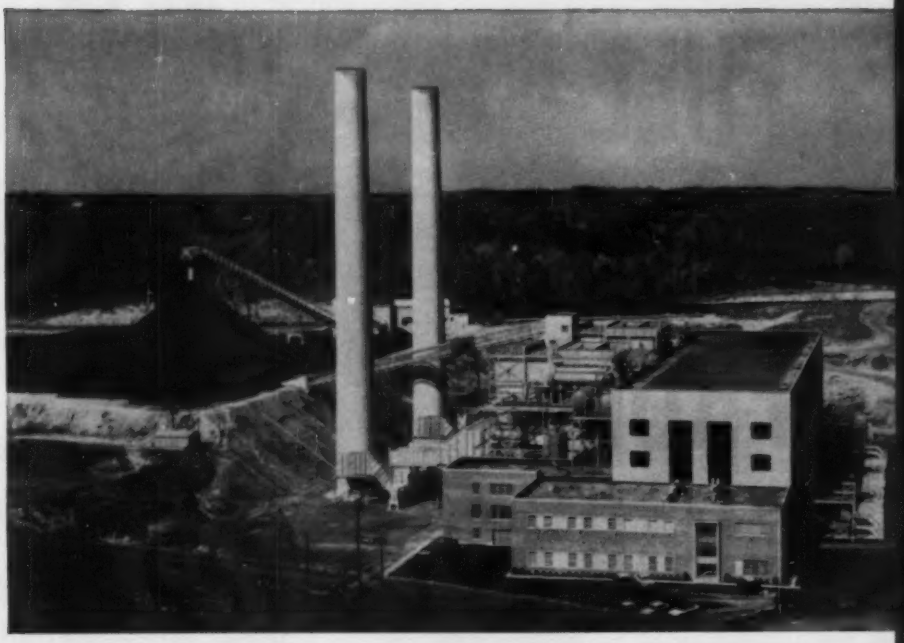
Republic patented electronic load control instantly proportions fuel flow, air flow, and feedwater flow to a precise measurement of unit load. The moment a turbine steam inlet valve setting changes, Republic's load control changes the firing rate—long before steam pressure can vary. Minor pressure variations due to inaccuracy of fuel measurement impose a final adjustment to return steam pressure to the set point. Correct steam pressure is quickly restored because these small deviations from set point require proportionately short intervals for correction. Pressure swings are practically eliminated.

Accurate Control of Fuel-Air Ratio. Electronic load control makes it practical to control air flow directly from energy output or total steam flow. Fuel flow changes immediately with a change in steam flow, and only final trimming of fuel from steam pressure is required. The time interval between air flow change and fuel flow change is insignificant. Thus, with fuel flow and air flow changing simultaneously, air flow is proportioned directly to steam flow, and safe, accurate control of fuel-air ratio is maintained.

More Stable Feedwater Control. Feedwater flow is proportioned to the master load signal from the Republic load control system. It is also modulated by the drum water level. This provides the final minor correction that maintains the drum water level at the setpoint without excessive controller action.

LOWEST BTU INPUT PER KWH

Silas C. McMeekin Station of South Carolina Electric and Gas Co., established a fine record of 9,093 BTU input per net KWH output, according to the latest Federal Power Commission Report. Equipped with a Republic electronic combustion and load control system (central control room shown above), the new McMeekin station (right) has a capacity of 250 MW with its two 910,000 lb/hr boiler systems.



Faster Response, Greater Efficiency

Improved Steam Temperature Control. Under load control, under-firing and over-firing are greatly reduced because firing rates are quickly matched to energy output. The fuel air ratio is accurately controlled. Combustion gas flow and temperature are maintained at boiler design levels, minimizing the correction required of the steam temperature control equipment.

In Duty Since 1949. Republic pioneered electronic combustion controls with the first such system installed in Commonwealth Edison's Ridgeland Station in 1949. More than 125 Republic electronic combustion control systems have been installed totalling more than 400 unit years of operation.

Republic patented electronic load control is typical of Republic engineering leadership for over 50 years. Let a thoroughly experienced Republic sales engineer help you with your instrument and control problems. Contact your nearest Republic representative, or write Republic Flow Meters Co., 2240 Diversey Parkway, Chicago 47, Illinois. In Canada: Republic Flow Meters Co., Ltd., Toronto, Subsidiary of Rockwell Manufacturing Co.

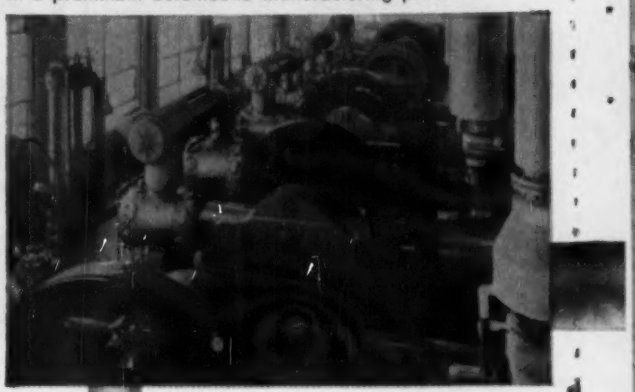
REPUBLIC INSTRUMENTS AND CONTROLS
more fine products by
ROCKWELL

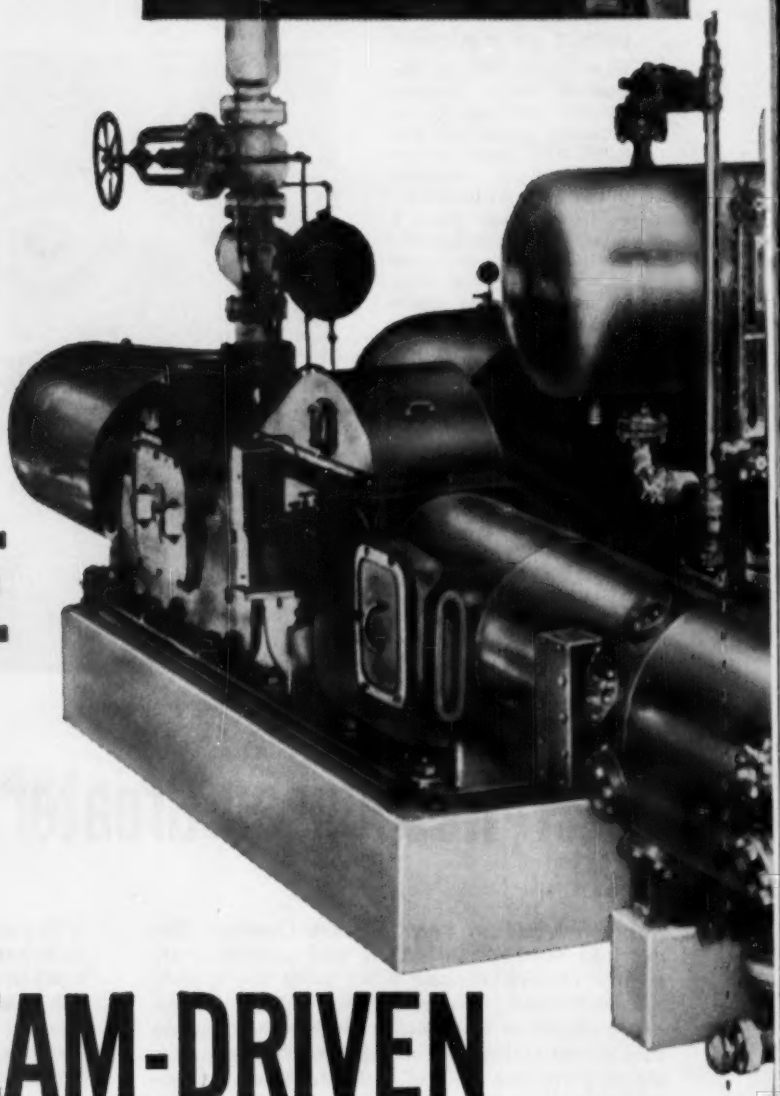
For more facts circle 218 on Reader Service card, p 103

Steam-driven compressors are still preferred where there is a need for exhaust steam for heating or process work, and where it is important to protect against shut-down in the event of electric power failure.

Chicago Pneumatic offers a complete line of steam-driven compressors from 20 to 1250 h.p., and for discharge pressures varying from vacuum to 15,000 p.s.i.g.

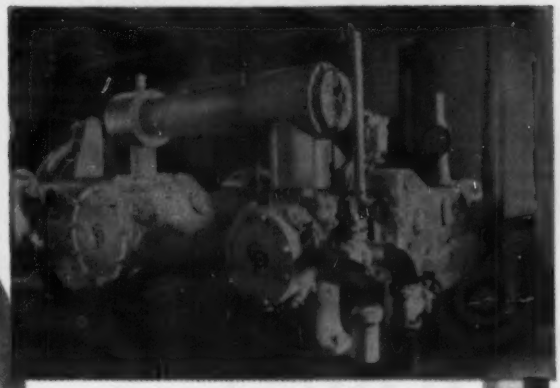
A battery of three Class H steam-driven compressors and two electrically-driven compressors installed in a prominent automobile manufacturing plant.



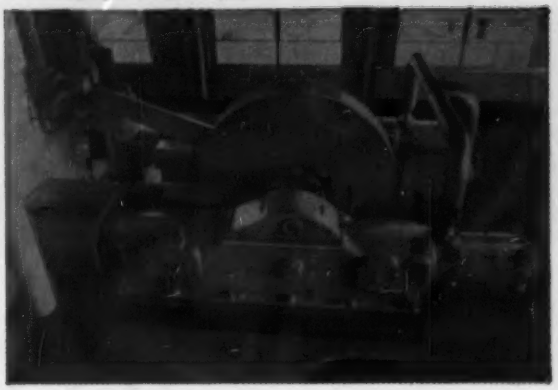


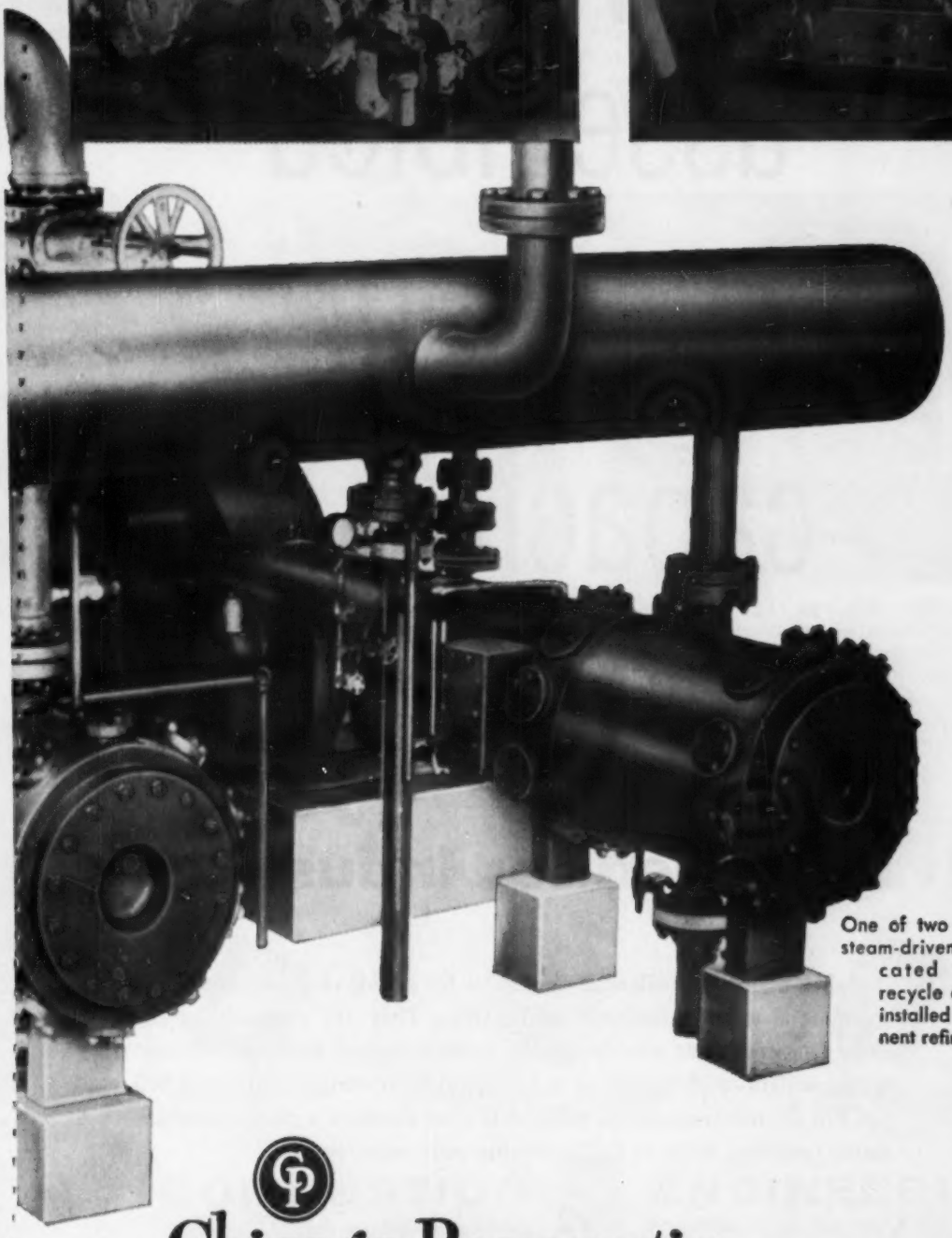
GET FULL VALUE FROM AVAILABLE STEAM... WITH CP STEAM-DRIVEN COMPRESSORS

Class H steam-driven compressor with simple steam end furnishing general refinery air.



Class H four-corner, steam-driven, single-stage booster compressor handling hydrocarbon gas.





One of two four-corner, steam-driven, non-lubricated hydrogen recycle compressors installed in a prominent refinery.

Chicago Pneumatic *8 East 44th Street, New York 17, N. Y.*

AIR AND GAS COMPRESSORS • VACUUM PUMPS • PNEUMATIC TOOLS • ELECTRIC TOOLS • DIESEL ENGINES • ROCK DRILLS • HYDRAULIC TOOLS

For more facts circle 219 on Reader Service card, p 102

shop-assembled to 120,000 lb/hr capacity

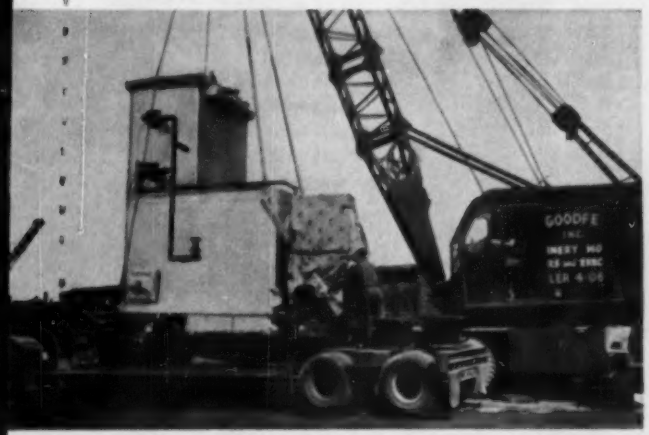
Designed for Industry by

C-E shop-assembled boilers are available for a wide range of industrial, commercial and institutional applications. They are produced by the same C-E engineers who design the world's biggest and most efficient utility boilers—with capacities to 4,000,000 lb/hr and pressures to 5,000 psi. For the most economical solution to *your* steam or high-temperature water problems, write to C-E, outlining your requirements.

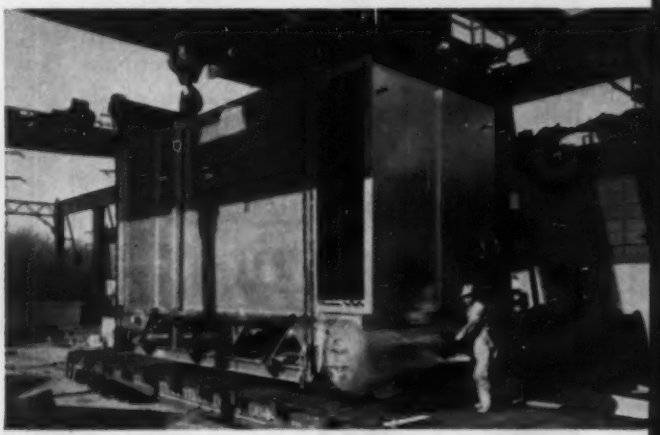
ALL TYPES OF STEAM GENERATING, FUEL BURNING AND RELATED EQUIPMENT; NUCLEAR REACTORS;

To 90,000 lb/hr . . . Type VP—A compact, economical, natural circulation, *package* boiler for the majority of industrial requirements. Steam capacities from 4,000 to 90,000 lb/hr; pressures to 700 psi; temperatures to 750 F. Most sizes shipped complete with firing equipment for oil or gas, setting and forced draft fan arrangement.

To 120,000 lb/hr . . . Type PCC—Shop-assembled *controlled circulation* boiler providing high output and high temperatures in a compact, high-performance unit. Capacities—80,000 to 120,000 lb/hr; pressures to 1,000 psi; temperatures to 900 F. Designed for minimum installation, operation and maintenance costs.



To 50,000,000 Btu/hr . . . Type HCC—High-temperature water boiler, shop-assembled, widely used for large-scale, economical heating of commercial and industrial installations—including many military air bases. Controlled circulation, pressurized oil or gas-fired from 10 to 50 million Btu; coal-fired to 40 million Btu. Field-assembled units to 300 million Btu.



To 50,000 lb/hr . . . Type WCC—Shop-assembled. Utilizes waste heat from open hearths or chemical processes. C-E controlled circulation design obtains big boiler performance from space-saving units. Capacities to 50,000 lb/hr—and up, depending on waste heat conditions—with pressures to 450 psi and temperatures to 750 F. Capacities of field-assembled units are virtually unlimited.

UTILITY-BOILER ENGINEERS

Write for catalogs—

C-E PACKAGE BOILER, TYPE VP

C-E CONTROLLED CIRCULATION PACKAGE BOILER, TYPE PCC

C-E CONTROLLED CIRCULATION HOT WATER BOILER, TYPE HCC

COMBUSTION ENGINEERING

Combustion Engineering Building
200 Madison Avenue, New York 16, N. Y.

CANADA: COMBUSTION ENGINEERING-SUPERHEATER LTD.

C-277

PAPER MILL EQUIPMENT; PULVERIZERS; FLASH DRYING SYSTEMS; PRESSURE VESSELS; SOIL PIPE

For more facts circle 220 on Reader Service card, p 103

IN GATEWAY CENTER'S
Centralized Air Conditioning System

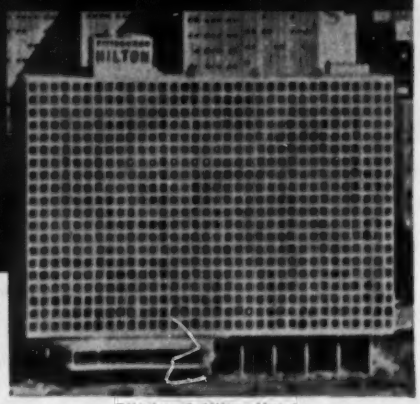
Owned and Operated by THE EQUITABLE LIFE ASSURANCE SOCIETY OF THE UNITED STATES

In Pittsburgh—One, Two and Three Gateway Center

Pumps Start and Stop Instantly... with

NO WATER HAMMER

New Four Gateway Center



Pittsburgh Hilton Hotel

WILLIAMS -HAGER

Silent Check Valves

One, Two and Three Gateway Center
Consulting Engineer: Meyer, Strong and Jones, New York
General Contractor: Starret Brothers and Eken, New York
Heating, Piping & Air Conditioning Contractor: Kerby Saunders, New York

Four Gateway Center
General Contractor: The George A. Fuller Company, New York
Piping Contractor: Wayne Crouse, Inc., Pittsburgh
Mechanical Engineer: Meyer, Strong and Jones, New York

Refrigeration Plant Extension
Mechanical Contractor: Limbach Company, Pittsburgh

Air conditioning for these five fine buildings is furnished from a centralized pumping system—with ten *Silent Check Valves* in the condenser system, five in the chilled water system. The valves also are used on domestic water systems for some of the individual buildings.

By operating whenever flow reversal starts or when flow is zero, the valves allow pumps to be put on or removed from the line immediately, with no need for hand-operated valves.

Write for Bulletins:
No. 654 on the Valves; No. 851 on Cause, Effect and Control of Water Hammer.

THE WILLIAMS GAUGE CO., INC.
160 Stanwix Street · 2 Gateway Center
Pittsburgh 22, Pa.
Our 74th Year · 1886-1960

For more facts circle 221 on Reader Service card, p 103

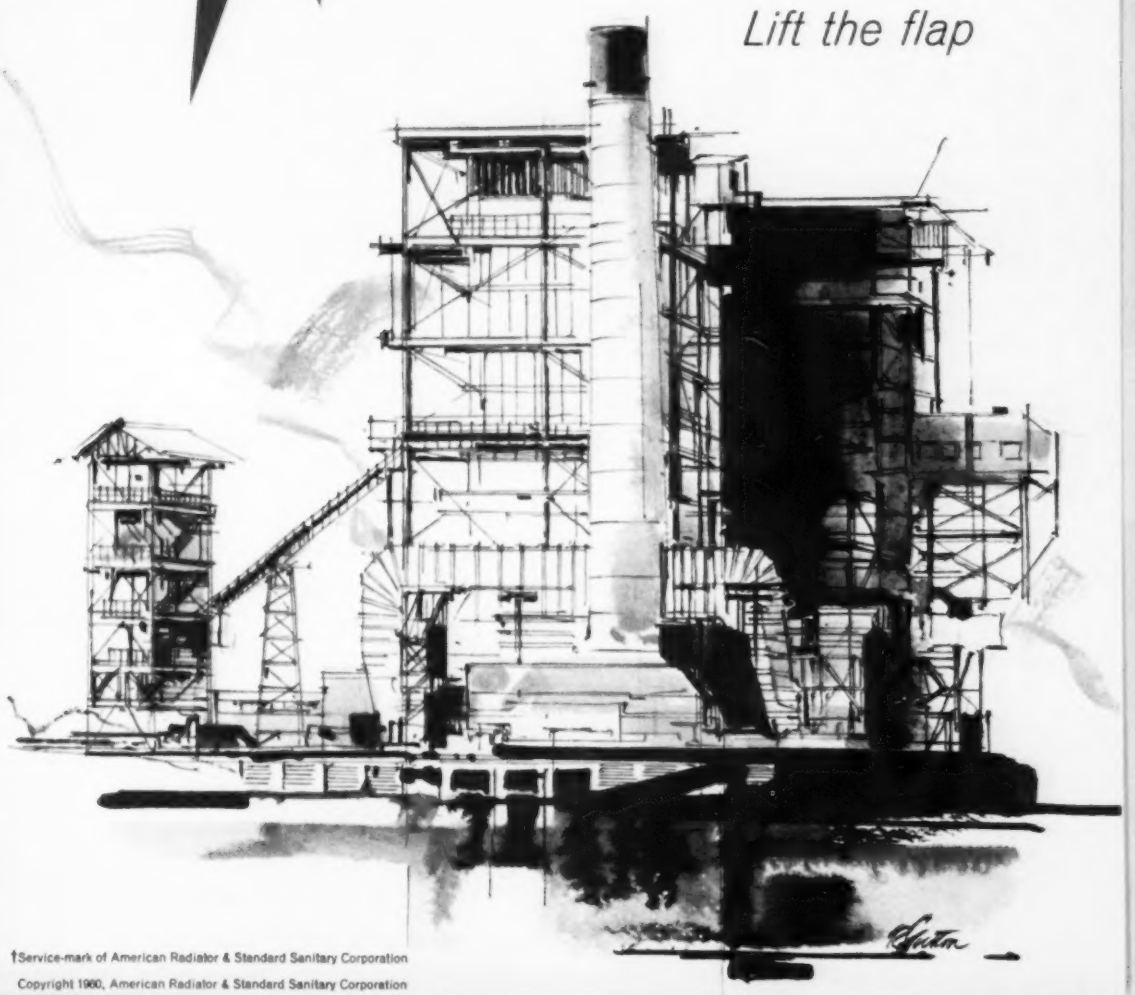
circle 222 on Reader Service card, p 103 ➤

From American-Standard Industrial Division

Power-Lift† for power plants through more rugged and simpler feedwater heaters

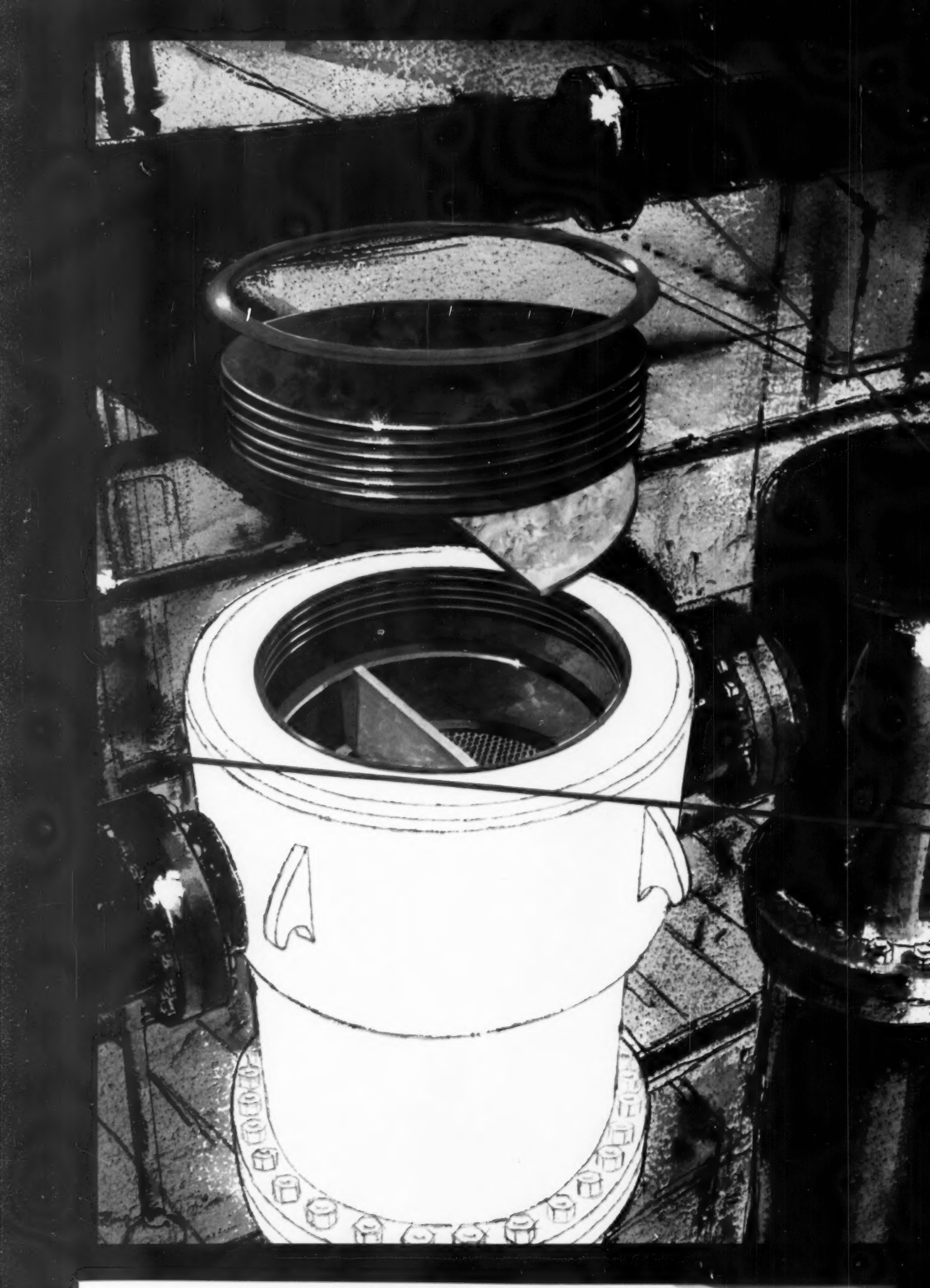
Power-Lift is a timely new concept of coordinated products and services from American-Standard Industrial Division. Its purpose is to help you raise overall efficiency in your plant. Its products are designed, engineered, and manufactured to a uniformly high standard of quality and performance...with service by product specialists in every major city. To see how Power-Lift can benefit you through simpler, more rugged feedwater heaters...

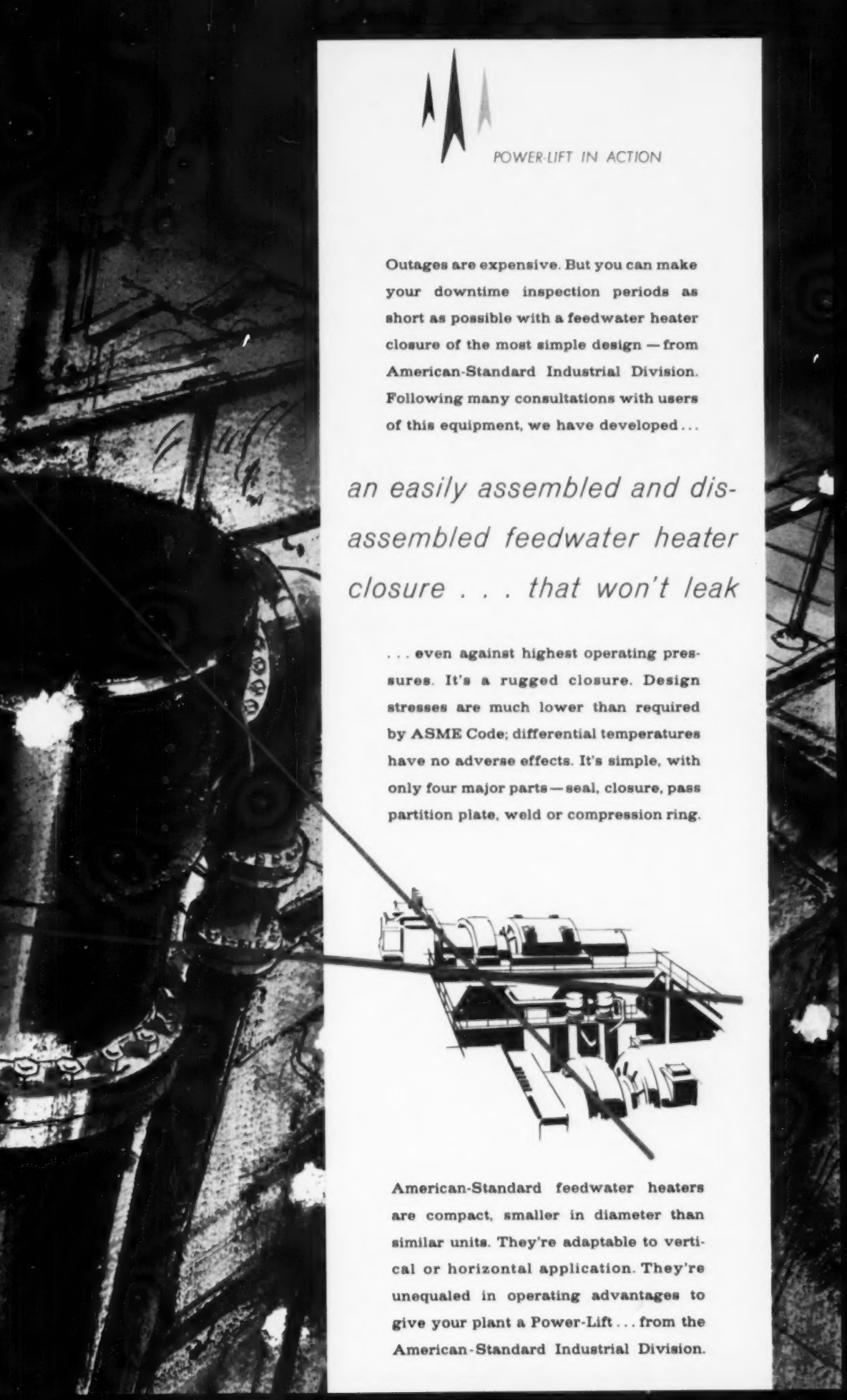
Lift the flap



†Service-mark of American Radiator & Standard Sanitary Corporation

Copyright 1960, American Radiator & Standard Sanitary Corporation





POWER-LIFT IN ACTION

Outages are expensive. But you can make your downtime inspection periods as short as possible with a feedwater heater closure of the most simple design — from American-Standard Industrial Division. Following many consultations with users of this equipment, we have developed...

an easily assembled and disassembled feedwater heater closure . . . that won't leak

. . . even against highest operating pressures. It's a rugged closure. Design stresses are much lower than required by ASME Code; differential temperatures have no adverse effects. It's simple, with only four major parts — seal, closure, pass partition plate, weld or compression ring.

American-Standard feedwater heaters are compact, smaller in diameter than similar units. They're adaptable to vertical or horizontal application. They're unequaled in operating advantages to give your plant a Power-Lift . . . from the American-Standard Industrial Division.

As near as your phone . . . **American-Standard Industrial Division Power-Lift Products and Services. Talk over your requirements with an American-Standard* Industrial Division product specialist. You'll find him well prepared and experienced —frequently able to base equipment recommendations upon precedents of proved success. And, in many instances, our comprehensive standardization paves the way to savings in time and cost. Offices in all principal cities. American-Standard Industrial Division, Detroit 32, Michigan. In Canada: American-Standard Products (Canada) Limited, Toronto, Ontario. Export Division, American-Standard, New York City.**

AMERICAN-Standard
INDUSTRIAL DIVISION

AMERICAN BLOWER PRODUCTS • ROSS PRODUCTS • KEWANEE PRODUCTS

Surface condensers — Designed to service the largest of today's and tomorrow's steam turbines. Low bundle entrance velocity; liberal steam transportation lanes; moisture impingement grids to extend tube life; expansion diaphragms; effective deaeration and many other features created during 40 years of surface condenser development and research.

Mechanical draft fans — Complete range of sizes and types for forced draft, induced draft, gas recirculating, and primary air fan applications. Designed to meet rigid requirements of modern power plants where maximum pounds of steam are produced daily at peak efficiency. Airfoil, forward curved, backwardly inclined, radial, radial tip blades.

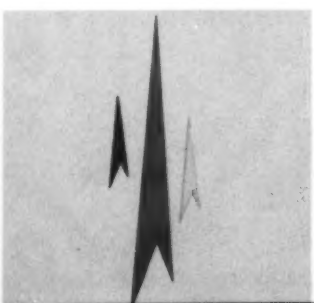
Feedwater heaters — Design incorporates unique new High Pressure Closure. Maintenance is simplified with only four major parts. Exceptionally high safety factor built into all units—more than double ASME Code requirements. Temperature stresses from start-ups or load changes virtually non-existent.

Heat exchangers — Designed and built with thoroughness and precision. Standard or specially engineered units for virtually all conditions and applications, including high pressure-high temperature exchangers, compressor inter- and after-coolers, fuel oil heaters, blow-down exchangers, and many others.

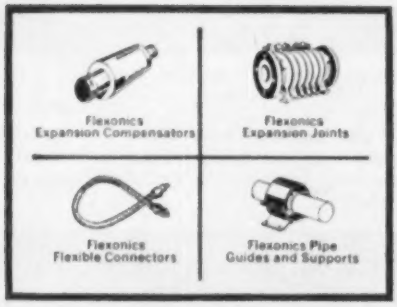
Gyrol® fluid drive — Provides stepless adjustable speed control for fans and boiler feed pumps. Performance, power savings, and reliability proved in the field. Units for motor driven boiler feed pumps or for "on-the-shaft" duty on main turbine generator. Drives are available for fan and pump duties for all boiler sizes.

Fly ash and dust collectors — Type "D" Dust Collector: mechanical "cyclone-type" collector. Series 342 Dust Collector: uses "cyclone" principle, with individual tubes which permit flexibility in design to fit plant layout. Series 361 Dust Collector: combines primary and secondary systems for high efficiency fly ash recovery.

*American-Standard and Standard® are trademarks of American Radiator & Standard Sanitary Corporation



HARNESS PIPE MOVEMENT WITH FLEXONICS EXPANSION JOINTS



Here's how to keep pipe movement under control! **Flexonics Self-Restrained Dual Expansion Joints** can absorb large amounts of lateral movement while keeping anchor forces at a minimum. **Flexonics Pressure Balanced Expansion Joints** replace main anchoring at changes in piping direction, by restraining the end thrust.

These are just two of the standard and special types of expansion joints engineered and built by Flexonics to help you harness pipe movement. **Check and mail the coupon today for complete information.**

EJMA **Member Expansion Joint Manufacturers Association**

EJ-260

Flexonics
corporation

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ont.

EXPANSION JOINTS · METAL HOSE · SYNTHETIC HOSE · BELLOWS · AERO/SPACE COMPONENTS

SUBSIDIARY OF CALUMET & HECLA, INC.

ATTACH TO YOUR LETTERHEAD—MAIL TODAY!

Flexonics Corporation
1301 South Third Avenue
Maywood, Illinois

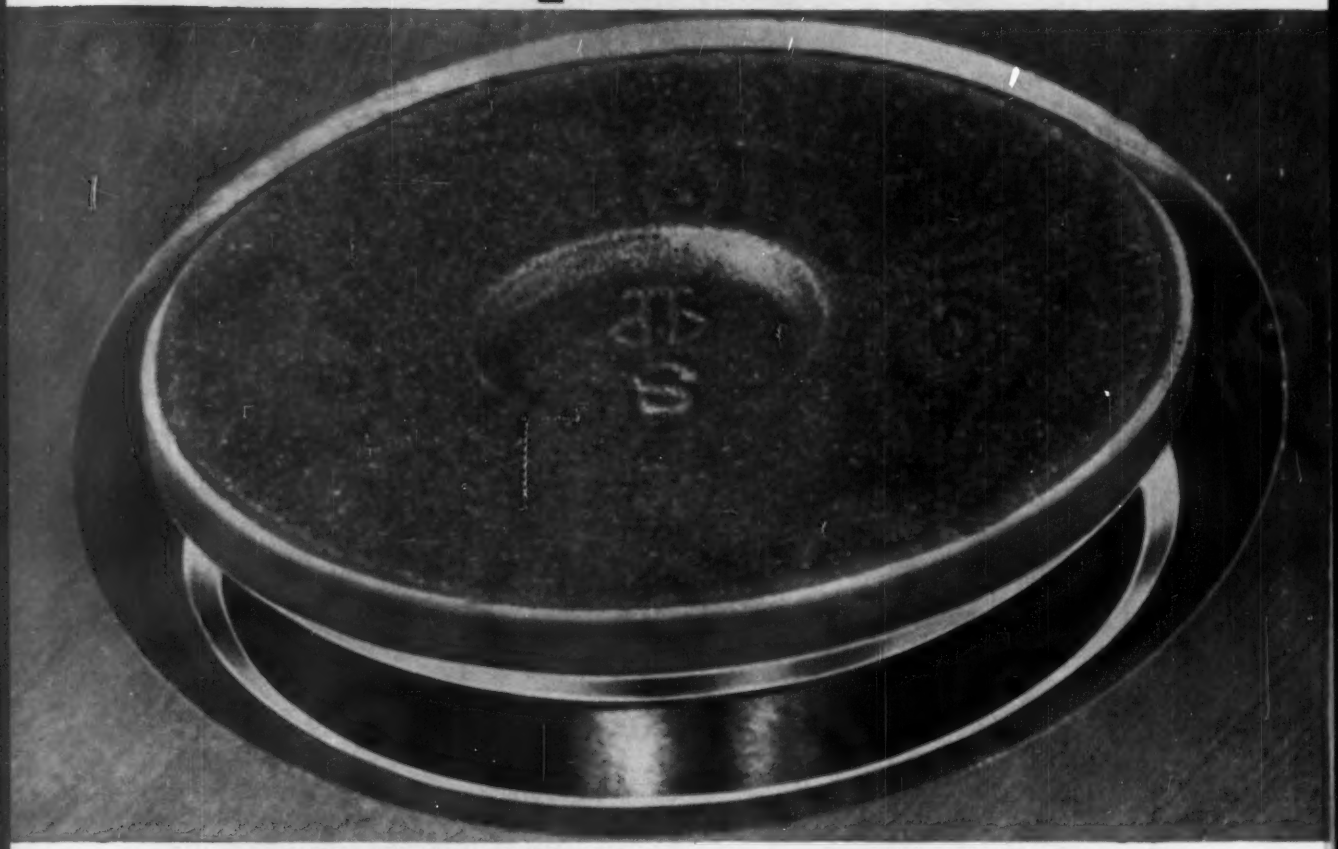
Please rush me complete information on

- ☐ Expansion Joints
- ☐ Expansion Compensators
- ☐ Flexible Connectors
- ☐ Pipe Guides and Supports

For more facts circle 223 on Reader Service card, p 103

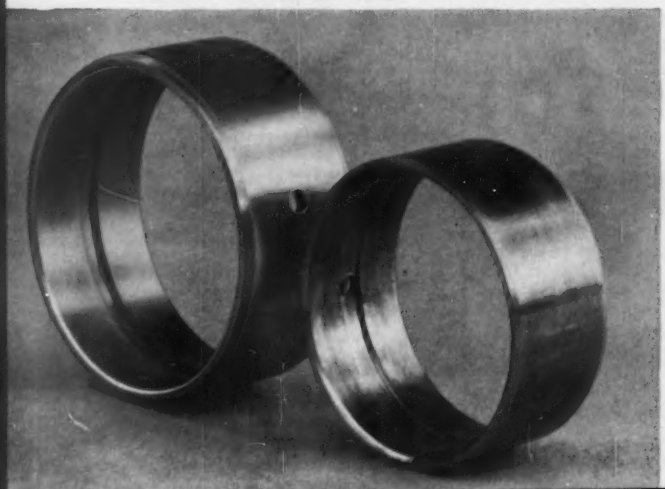
An amazing metal

up to 3 times



"Silver circles" as hard as Swedish steel make your Onan Plant last longer.

Big, brawny bearings—twice the size of many competitors' bearings—give Onan Plants a longer life between overhauls. Onan is built *up* to performance, not down to a price.



To give you greater assurance of top performance, inspectors from an independent laboratory periodically visit our factories to test units and production testing methods.

gives Onan engines
the valve life!

Onan exhaust valves and seats are coated with Stellite, a tough alloy, to greatly reduce wear and burning

Stellite—one of the toughest alloys known—gives the exhaust valves and seats in an Onan engine up to 300% longer life. Scorching punishment—Stellite can take it.

Onan's attention to important details, like valves and valve seats, is what makes Onan Plants so dependable, so long-lasting, so economical.

And, only Onan gives you Performance Certified. Every Onan Electric Plant is run for hours under full load before it leaves our factory to assure ourselves, and you, of getting all the performance and power you paid for. To give you even more assurance, inspectors from an independent laboratory come in periodically to double check our tests and testing methods. Whether you need primary or stand-by generating power, from 500 watts to 230,000 watts, see your Onan distributor. You'll find his name in the telephone classified section in every major city, or write direct.

ONLY ONAN GIVES YOU THIS GUARANTEE

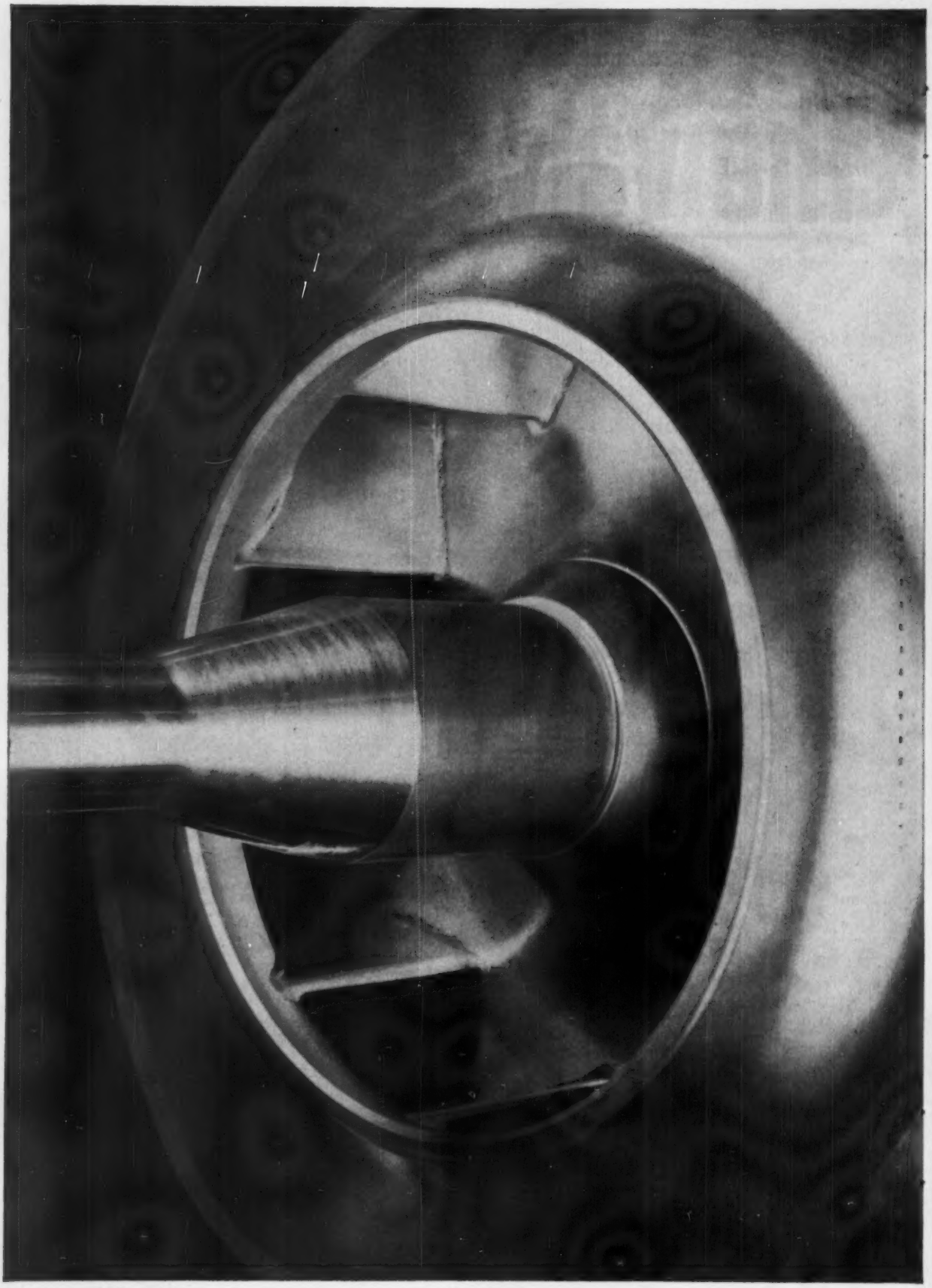
PERFORMANCE CERTIFIED
We guarantee that when properly installed and operated this Onan electric plant will deliver the full power and the voltage and frequency regulation promised by its nameplate and published specifications. This plant has undergone several hours of running-in and testing under realistic load conditions, in accordance with procedures certified by an independent testing laboratory.
D. W. ONAN & SONS INC.
Minneapolis 14, Minnesota
Onan

Onan®

World's Leading Builder of Electric Power Plants

D. W. ONAN & SONS INC., 2606 UNIVERSITY AVE. S.E., MINNEAPOLIS 14, MINN.

For more facts circle 224 on Reader Service card, p 103



Engineering Excellence Pays Off In Operating Efficiency

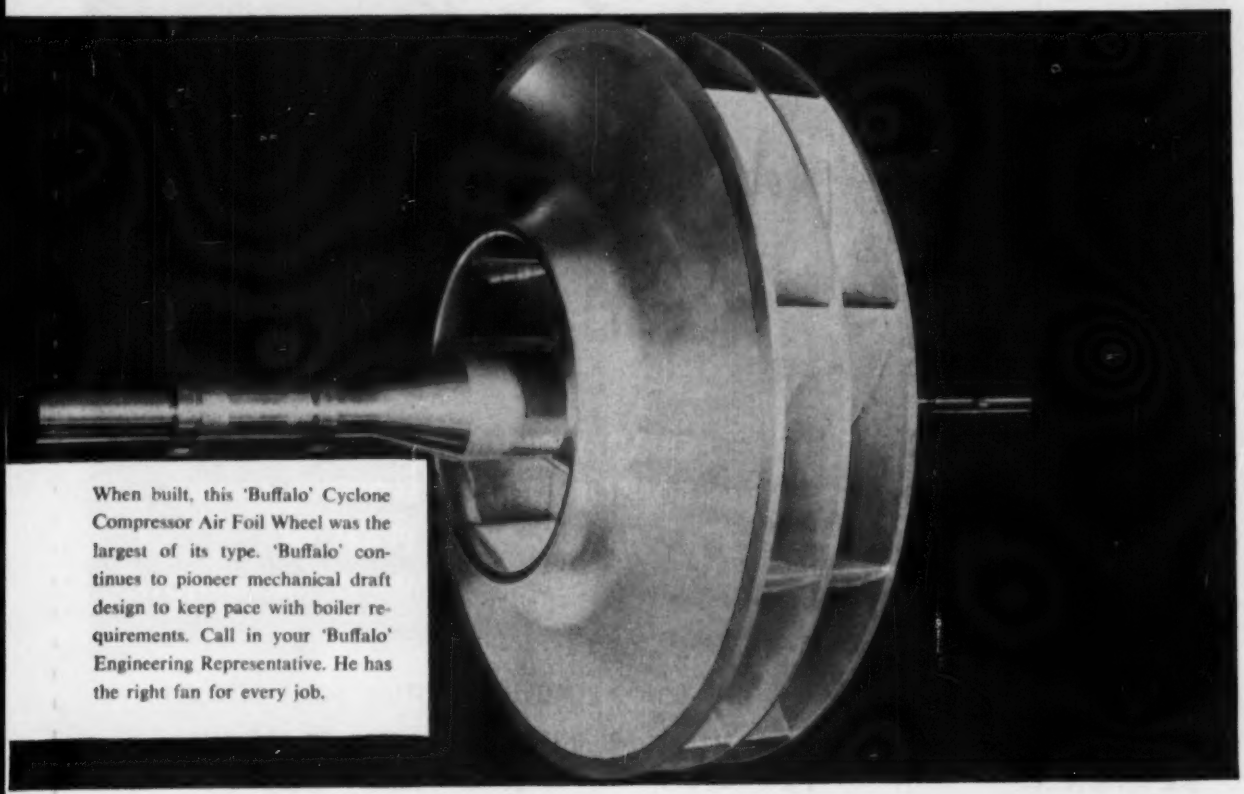
'BUFFALO' CYCLONE COMPRESSOR

HIGHLY EFFICIENT

Tailor-made to each job, these cyclone compressors provide power savings unobtainable with other designs. Exclusive engineering features such as generous inlet boxes, semi-circular inlet bell and matching wheel flange, deep air foil blades, streamlined scroll and divergent outlet all contribute to high static efficiency and lower noise levels.

TYPICALLY DEPENDABLE

Designed, engineered and built for years of continuous, trouble-free service. Hammered forgings, machined all-over, are used in all highly stressed areas. ¼"steel plate is used in housings and ½" plate in boxes. Engineered welding is double-checked by X-ray. Sleeve type bearings are supplied with circulating oil system where required. Engineered sound attenuators are available.



When built, this 'Buffalo' Cyclone Compressor Air Foil Wheel was the largest of its type. 'Buffalo' continues to pioneer mechanical draft design to keep pace with boiler requirements. Call in your 'Buffalo' Engineering Representative. He has the right fan for every job.

"Buffalo"

BUFFALO FORGE COMPANY

Buffalo, New York

Buffalo air handling equipment to move, heat, cool, dehumidify and clean air and other gases.

Buffalo Machine Tools to drill, punch, shear, bend, slit, notch and cope for production or plant maintenance.

Buffalo Centrifugal Pumps to handle most liquids and slurries under a variety of conditions.

Squier machinery to process sugar cane, coffee and rice. Special processing machinery for chemicals.

For more facts circle 225 on Reader Service card, p 103

SPECIALISTS IN INDUSTRIAL WATER TREATMENT
THE NORTH AMERICAN MOGUL PRODUCTS COMPANY
20th Floor Standard Bldg., Cleveland 13, Ohio
Your Mogul Man...Anywhere, U.S.A.

MEET THE MAN WHO CAN PROTECT & PRESERVE YOUR AIR CONDITIONING EQUIPMENT FROM THE DAMAGING EFFECTS OF WATER

HE OFFERS YOU...

* QUALITY PRODUCTS
* CONSCIENTIOUS & EFFECTIVE SERVICE BACKED BY 44 YEARS OF COMPANY KNOW-HOW.

SEND FOR LITERATURE

ALL BENEFITING YOU BY...

- REMOVING EXISTING SCALE DEPOSITS
- CONTROLLING WATER TO PREVENT SCALE • RUST • SLIME ALGAE • CORROSION • CONGESTION

New and increasingly complex cooling systems require advanced and thoroughly effective treatment programs. Protect your investment and be assured of uninterrupted and efficient operation with MOGUL PRODUCTS and MOGUL SERVICE.

The North American MOGUL Products Company

Standard Building • Cleveland 13, Ohio

For more facts circle 226 on Reader Service card, p 103

circle 227 on Reader Service card, p 103 ▶

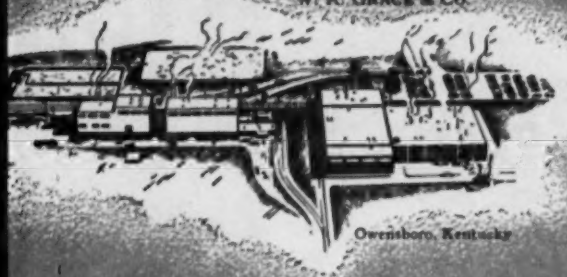
At the OWENSBORO, KENTUCKY PLANT
DEWEY and ALMY CHEMICAL DIVISION/W. R. Grace & Co.

2 Erie City 500 hp.

"FT" Package Boilers

"Our plant is equipped with two 500 hp. Erie City "FT" package steam generators gas or oil fired. 150-lb. steam from the generators is used for both building heat and operation of the process. Since the usage of process steam is split between continuous and batch operations, the generating equipment is called upon to operate under wide and rapidly varying load conditions. These Erie City Iron Works package steam generators have met our every requirement."

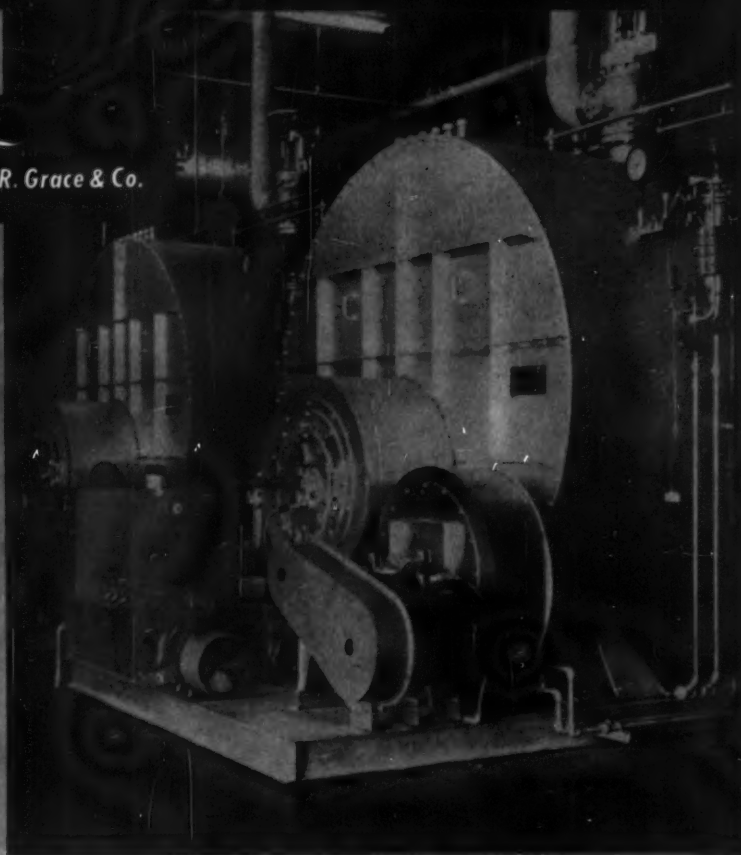
Harry Marty, *Plant Manager*
DEWEY and ALMY CHEMICAL DIVISION
W. R. GRACE & CO.



Owensboro, Kentucky

A FEW ERIE CITY "FT" USERS
in Process Industries the world over

Callery Chemical Co. Lawrence, Kansas	2—450 hp. "FT's"
Kermac Nuclear Fuels Co. Grants, New Mexico	2—450 hp. "FT's"
Federation Chemicals, Ltd. Trinidad, B. W. I.	2—600 hp. "FT's"
Meltor Chemical & Industrial Corp. Madras, India	2—300 hp. "FT's"
Stauffer Chemical Co. Houston, Texas	1—300 hp. "FT"
National Potash Co. Carlsbad, New Mexico	1—300 hp. "FT"
Chemstrand Corp. Greenwood, S. C.	1—600 hp. "FT"



It pays in many ways to buy the top quality package boiler—Erie City "FT"

This modern plant at Owensboro, Kentucky, is completely automatic and quality control is the key to its success. The completely automatic gas or oil fired 500 hp. "FT's" fit naturally into this most technically advanced operation.

"FT's" are produced by the same skilled craftsmen who manufacture the large, high pressure Erie City steam generators. That's why you will find "FT's" where dependability and availability are a must.

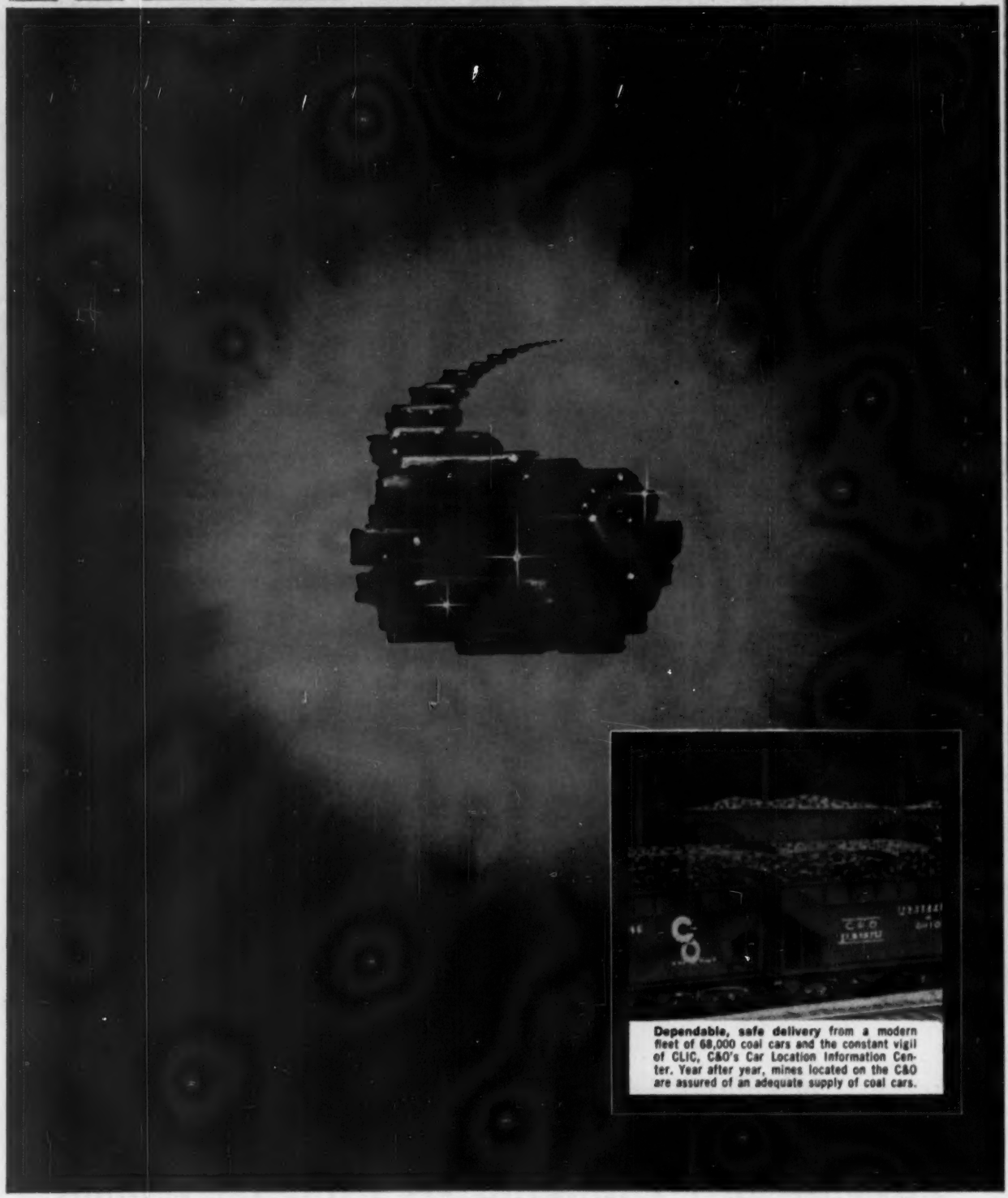
The Erie City "FT" firetube package unit is built up to the highest quality standards not down to a price. For complete information, write for Catalog SB5601-G.

You can depend on ERIE CITY Since 1840 *for sound engineering*

ERIE CITY IRON WORKS • Erie, Pa.

STEAM GENERATORS • • • SUPERHEATERS • • • STOKERS • • • PULVERIZERS
ECONOMIZERS • • • WASTE HEAT BOILERS • • • OIL and GAS BURNERS
AIR PREHEATERS • • • FIRE and WATER TUBE PACKAGE BOILERS

REDISCOV



Dependable, safe delivery from a modern fleet of 68,000 coal cars and the constant vigil of CLIC, C&O's Car Location Information Center. Year after year, mines located on the C&O are assured of an adequate supply of coal cars.

ER COAL !

COAL IS CERTAIN – available for centuries in quality and quantity

In Chessie's coal basin alone, the tremendous recoverable reserves point out the basic good reason for coal's steady growth in utility, metallurgical and industrial markets. For coal is certain—the one fuel offering a stable, economic supply for *centuries, not decades.*

Today's mines, and tomorrow's, are rich in high quality bituminous coal . . . economically available through modern mechanized mining technology . . . transported dependably and at low cost by Chesapeake & Ohio . . . capable of producing peak BTU efficiency in advance-design combustion equipment.

It will pay anyone faced with the problem of modernization to *rediscover coal* in terms of reliability, economy, efficiency, and convenience. Today, or centuries from now, there will be ample supply to outlive the life span of the finest combustion plant.

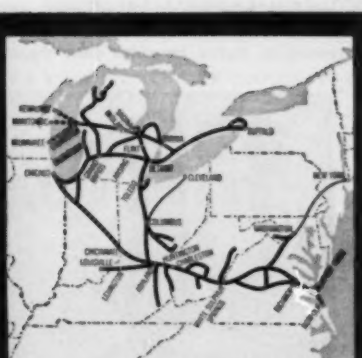
Chesapeake and Ohio Railway

Terminal Tower • Cleveland 1, Ohio

Outstandability in Transportation

Coal is clean as well as economical for modern institutional heating. Advancements in handling and combustion equipment, electrostatic precipitators and other devices to prevent air pollution make coal the ideal fuel.

C&O Fuel Service Engineers offer free consultation in C&O's market areas on any problem of combustion, application, equipment or plant arrangement. Write to: R. C. Riedinger, General Coal Traffic Manager, at the address above.



Chessie's 5100-mile Route directly serves over 300 fine bituminous coal mines. C&O's vast coal operation includes transshipping terminals at Presque Isle at Toledo, Ohio and Newport News on Hampton Roads, Va.

CHESSIE SERVES THE COAL BIN OF THE WORLD

For more facts circle 228 on Reader Service card, p 103

STEAM TURBINE-GENERATORS

By N. K. Halsteen, Project Engineer, Brown Boveri Corp.

BROWN BOVERI

In 1901, Brown Boveri built the first steam turbine installed on the European continent. This turbine was also the world's largest. Since then, the company has made many basic contributions to turbine design and has built more than 5300 steam turbines for generating electric power and for driving blowers and compressors.

Brown Boveri steam turbine-generators include these types and sizes:

Condensing units offer highest efficiency, lowest steam consumption. All ASME Preferred Standard sizes. Single-shaft units to 350 mw. Cross-compound units to 500 mw and up.

Back-pressure units are rated at 500 to 30,000 kw and supply exhaust steam at 20 to 350 psia for low-pressure condensing units or for process.

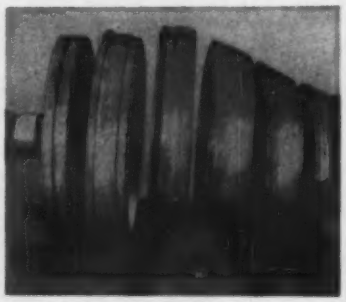
Extraction-condensing units are rated at 1000 to 100,000 kw. Extraction steam at 7 to 15 psia is used for process and for heating water in municipal heating systems.

A Brown Boveri 30/33 mw Preferred Standard unit at Greenwood Mills, S. C.

Sectional rotors

Brown Boveri turbine rotors are made of forged sections welded together at the rims. This construction offers advantages over one-piece rotors: The relatively small size of each section ensures a more uniform forging and allows more thorough inspection. Sections with flaws are rejected and replaced virtually eliminating patching often required to salvage large one-piece forgings.

Asymmetries are cancelled out by the random positioning of adjacent sections. The low weight of a hollow, sectional rotor provides fast warm-up and rapid, uniform heat distribution in service. The sectional design eliminates axial stresses. Completed rotors are given ultrasonic tests and stress-relieving heat treatment. *No explosions or other serious failures have ever been experienced with Brown Boveri sectional rotors.*



Sections of a steam turbine rotor before welding. Welding is done automatically by an inert-gas process.

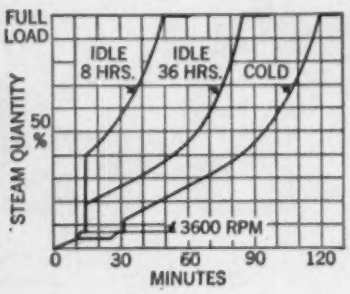
Hydraulic governing system

The Brown Boveri all-hydraulic, governing system uses no mechanical links and thus eliminates joint play or thermal expansion of links which may cause "hunting." Synchronization is quick, simple. On high-temperature reheat units, the governing system is separate from the lubricating oil system and uses a non-combustible fluid.

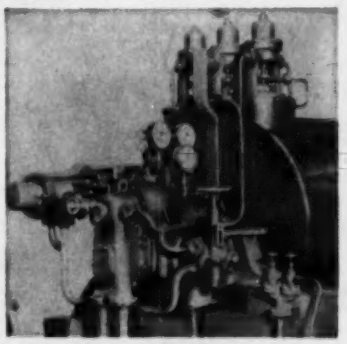
Fast start-up, flexible loading

The low weight of the rotor, lightweight casings and special flange-heating systems reduce temperature differences in the machine to a minimum . . . allowing fast and cold starts, fast changes in load and fast shut-downs without dangerous expansion differentials. Close radial tolerances can be maintained.

These advantages, together with simple synchronizing, are particularly useful where frequent start-ups are required . . . as for peaking.



Starting schedules for a large multi-cylinder reheat turbine . . . illustrating how quickly temperatures in the machine are equalized.



Brown Boveri linkage-free pressure oil governing system. Turbine may also be started and shut down with a single handwheel.

Service

Brown Boveri maintains installation crews and service shops in the U. S. and Canada . . . also working agreements with Todd Shipyard Corp. and National Electric Coil Co. whose shops can rebuild or repair the largest turbines and generators now in use and who have an outstanding record for fast, efficient service.

BROWN BOVERI Brown Boveri Corp., Dept. P7, 19 Rector Street, New York 6, N. Y. Agents in 27 U. S. cities.

For more facts circle 229 on Reader Service card, p 103

Only Morton offers salt service for water conditioning needs everywhere

Wherever your plant is located, whatever your needs may be, Morton, the only nationwide salt company, can supply the kind of salt and service necessary for top performance from your brinemaking equipment.

Morton Purex is a special high-purity evaporated grade of salt that is 100% soluble. Purex dissolves rapidly and uniformly, producing a clear, fully saturated brine at highest possible flow rates. Leaves no residue in brine storage chambers.

Morton '999' is another high-purity evaporated salt. It is particularly suitable for use in de-alkylizing units.

Morton Rock Salt is economical to use and comes in several grades and sizes. Morton can supply the grade best suited to your needs.

Morton Solar Salt is available in extra coarse, coarse and medium grades and is recommended as an economical, high purity salt for use in West Coast water conditioning installations.

Mail coupon today for more information about the various grades of salt and the valuable service Morton offers the Water Conditioning Industry.

PLEASE SEND ME ADDITIONAL INFORMATION ON

_____
(type of salt)

I ALSO WOULD LIKE TECHNICAL HELP CONCERNING

_____
(type of water conditioning problem)

_____

_____

Name_____

Title_____

Company_____

Address_____

City_____ Zone_____ State_____

MORTON SALT COMPANY

INDUSTRIAL DIVISION

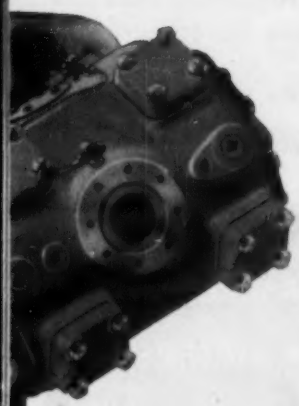
Dept. P7, 110 North Wacker Drive, Chicago 6, Illinois

For more facts circle 230 on Reader Service card, p 103

NEW
COOPER-BESSEMER
DMR-3 THREE-STAGE
AIR COMPRESSOR
FOR
SOOT-BLOWING
200 TO 400 HP

S. D. Greiner, *Air Compressor Sales Engineer,*
The Cooper-Bessemer Corporation, explains...

How Cooper-Bessemer's new, compact Air Compressors cut soot-blowing costs



Compressed air provides important cost savings for soot-blowing in coal or oil-fired power plants. Glance at the list of advantages shown at the right.

Now, Cooper-Bessemer introduces further economies in favor of AIR as the soot-blowing medium. The new line of DMR Air Compressors provides a new standard of *installation* economy. So highly *compact,* the DMR units can be installed in small space, conserving on floor area and making it possible to locate them near the boiler for greatest efficiency.

The new DMR units come completely equipped with integral motor-drive and intercooler... ready for operation. Control can also be integrally mounted as shown. They are available for three-stage applications in the range of 687 to 1029 cfm free air and discharge pressures of 350 and 500 psi.

Complete details on this new line of Cooper-Bessemer air compressors are given in Bulletin No. 94. Call the nearby Cooper-Bessemer office or air compressor agent for your free copy.

ECONOMICS OF BOILER CLEANING WITH COMPRESSED AIR (VERSUS STEAM)

1. Pressure is always adequate to do clean, thorough job.
2. Better programming with air... gets better cleaning results for higher boiler efficiency.
3. Lower cost for blowing medium ... less waste.
4. No quenching action on hot alloy tubes or pressure vessels.
5. Much less maintenance of blower equipment due to erosion, corrosion, packing wear.
6. Improved housekeeping... no steam or condensate leakage.
7. Greater over-all economy of blowing medium on evaluated basis.
8. Eliminates condensate makeup required when blowing with steam.

BRANCH OFFICES: Grove City • New York • Washington • Gloucester Pittsburgh • Chicago • Minneapolis • St. Louis • Kansas City • Tulsa • New Orleans Shreveport • Houston • Greggton • Dallas • Odessa • Pampa • Casper • Seattle San Francisco • Los Angeles

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Cooper-Bessemer, S.A.... Chur, Switzerland • The Hague, Netherlands • Mexico City

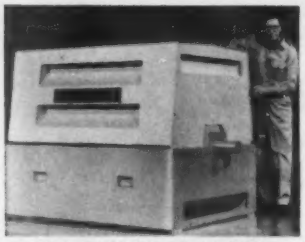
The Rotor Tool Company... Cleveland

Cooper Bessemer

GENERAL OFFICES: MOUNT VERNON, OHIO

ENGINES: GAS - DIESEL - GAS-DIESEL
COMPRESSORS: RECIPROCATING AND CENTRIFUGAL
ENGINE, TURBINE OR MOTOR DRIVEN

For more facts circle 231 on Reader Service card, p 103

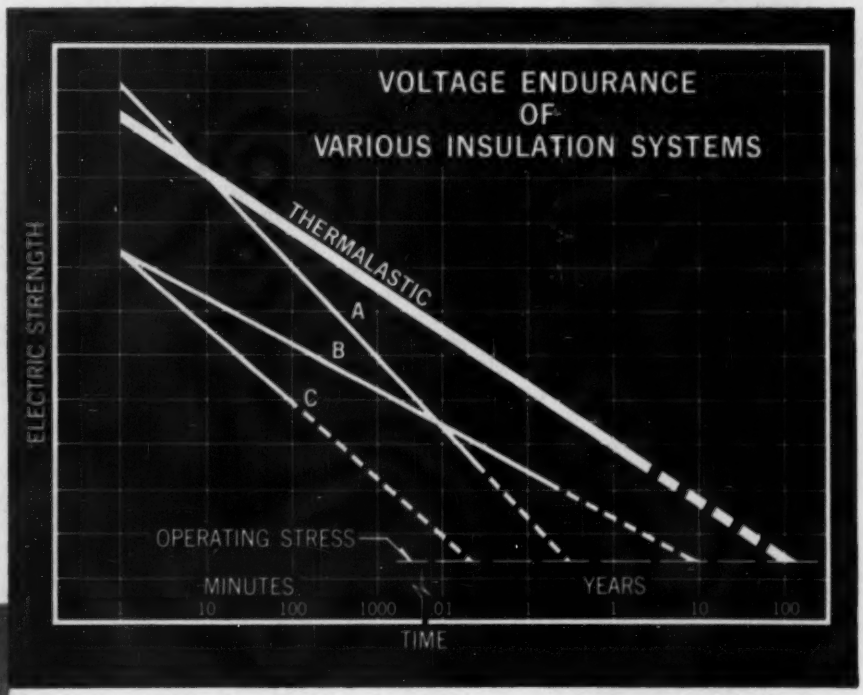


MORE VALUE FOR YOUR LARGE MOTOR INVESTMENT . . .

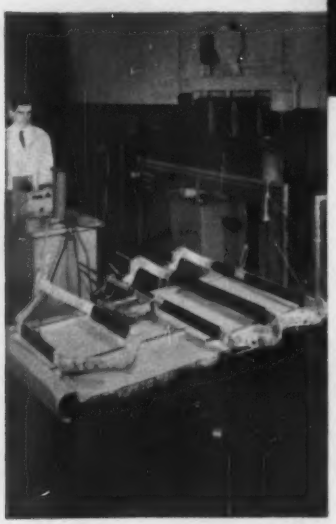
Westinghouse F/A Motor insulation

Thermalastic®, the "insulation with a memory," has been protecting the coils in more than 50,000,000 kw of Westinghouse large rotating apparatus since its development in 1949. In that time the three or four coil failures experienced have resulted from mechanical causes . . . not one failure of Thermalastic insulation itself has occurred.

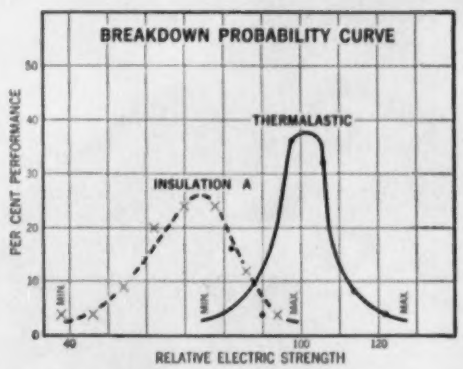
Helping to assure this outstanding performance are rigid laboratory tests which show Thermalastic insulation to be 20 times longer lived than other insulations. Tests on 4160-volt



Voltage endurance: This chart shows the results, plotted and extrapolated on a semi-logarithmic scale, of voltage endurance tests performed on several types of insulation. The combination of properties shown here by Thermalastic is unequaled—high initial dielectric strength and excellent voltage endurance.



In this destructive electric strength test, several insulated coils are picked at random. The various voltages at which failures occur are noted and plotted to form a breakdown probability curve (right). Thermalastic shows more consistent performance and at higher levels.



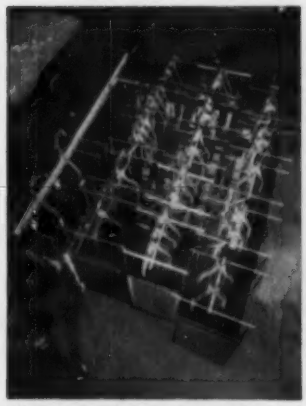
YOU CAN BE SURE...IF IT'S
TUNE IN WESTINGHOUSE-CBS TV-RADIO

tests show probable 100-year life!

windings with Thermalastic insulation indicated a probable life expectancy of at least 100 years!

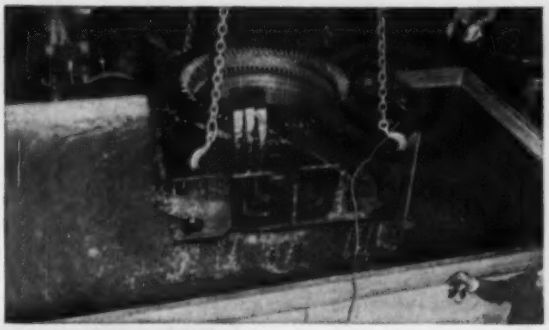
The key to this surprisingly long effective life is Thermalastic's unique molecular structure. Large overlapping mica splittings are locked in a void-free elastic bond which expands and contracts with the coil. Thus, a perfect dielectric barrier is maintained under all operating conditions, easily warding off the attacks which weaken and destroy ordinary insulation. Thermalastic is used on all F/A Motors and is another reason why the Westinghouse F/A gives you more value for your large motor investment.

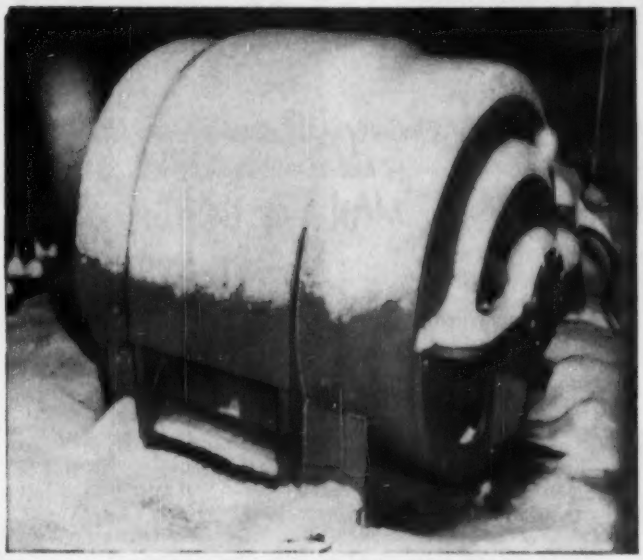
J-15017



Moisture resistances of various types of insulation are measured in this submersion test. Of all systems tested, Thermalastic has proven to be the most reliable system under long exposure to moisture.

Complete windings: Tests on coils do not always indicate the resistance to moisture of a complete winding. The test pictured here involves immersion of a completely wound stator. Measurement of insulation resistance showed no deterioration of any kind in Thermalastic-insulated stators.





Service tests: This conventional indoor 600-hp motor with Thermalastic insulation has been running outdoors for more than three years. Built before the F/A Motor was introduced, it has been subjected to these rigorous conditions:

- Twenty-four hours a day, five days a week, with weekend shutdowns to approach normal operating conditions.
- Summer and winter weather, with all moisture and temperature extremes.

It is still running smoothly and shows no sign of insulation breakdown or other deterioration.

COMPARE! how much costly down time has insulation failure caused in your plant?

USE THIS SIMPLE CHART TO MAKE YOUR OWN COMPARISON

	THERMALASTIC	YOUR INSULATION
Number of years	11	
Cost of repairs	0	
Hours of down time	0	

There is a Westinghouse F/A Motor to fill all your large motor needs. Call your Westinghouse representative, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pa.

Westinghouse

COVERAGE, PRESIDENTIAL CONVENTIONS, JULY 10-29.

For more facts circle 232 on Reader Service card, p 103

USED TO THINK EVERY STEAM TRAP LEAKED STEAM.

THEN I FOUND ONE THAT DIDN'T, BUT IT WOULDN'T VENT AIR.

FOUND ONE THAT VENTED AIR, BUT IT NEEDED A GOOSE LEG.

DISCOVERED A TRAP THAT REMOVED CONDENSATE AT STEAM TEMP, -MAINTENANCE WAS TOO HIGH.

THEN I FOUND A ~~LOW~~ MAINTENANCE TRAP. IT DIDN'T WORK AGAINST BACK PRESSURE.

AT LAST I FOUND ONE THAT WORKED AGAINST BACK PRESSURE, BUT ITS CAPACITY RATING WASN'T DEPENDABLE.

ARMSTRONG PROMISES TRUE CAPACITIES AND EVERYTHING ELSE. SO I CALLED THEM. THEY TOLD ME TO RELAX. I COULDN'T.

THEY TOLD ME ABOUT ARMSTRONG'S GUARANTEE. WHAT'S I HAVE TO LOSE. I TRIED THEM.

EFFICIENCY IS UP, FUEL BILLS ARE ~~DOWN~~, SO ARE MAINTENANCE COSTS. MAN I'M LIVING!

No one trap can do *everything* better than every other trap. Some traps vent air better than others, some remove condensate faster, etc. But, there is no one trap *best* in every phase of trapping. Armstrong has been manufacturing the Inverted Bucket Trap for nearly fifty years, and though the traps have changed with the requirements of the times, the Inverted Bucket principle has remained. For on overall trap performance, year-in and year-out, nothing beats the Armstrong Inverted Bucket Trap. It's a rugged well-built trap that does *more* things better than any other trap. It's guaranteed because it's been proved.

For more details, see your Armstrong Representative and start living . . .

P. S. Like some good meaty reading? Ask for the 48-page Armstrong Steam Trap Book.

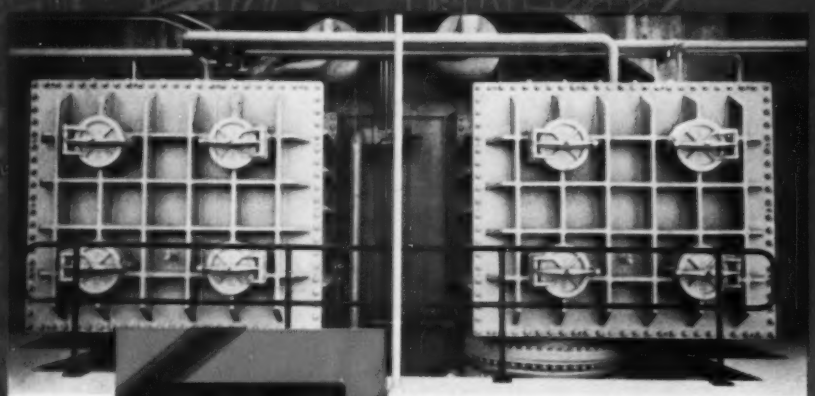
ARMSTRONG MACHINE WORKS
8127 MAPLE STREET
THREE RIVERS, MICHIGAN

611-ST

where trouble-free performance is a matter of pride...

FLORIDA POWER & LIGHT COMPANY

Lauderdale Plant



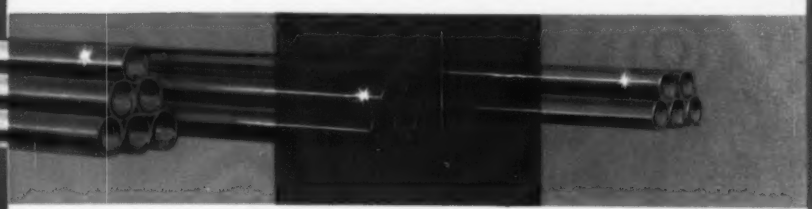
Typical condenser installation in the Lauderdale Plant employing approximately 352,000 linear feet of Scovill Aluminum Brass Heat Exchanger Tube, ¾" O.D., 0.049" wall thickness.

HEAT EXCHANGER TUBE

The new Lauderdale Plant of the Florida Power & Light Company is the largest power producing unit in Florida. Its condensers are tubed with Scovill ALUMINUM BRASS Heat Exchanger Tube, selected to assure trouble-free performance under specific conditions at this important station.

Aluminum Brass is a Scovill alloy that has proved to be highly resistant to corrosion by salt and brackish waters and to the combined effects of corrosion and erosion in salt water service. These good qualities are due to the special nature of the thin, adherent, continuous and self-renewing film which develops on the surfaces of this alloy in service. It is being extensively used in marine and tidewater condenser installations.

Your own condenser and heat exchanger service conditions may be similar or they may be entirely different and perhaps better served by one of Scovill's eleven other popular Tube Alloys. Scovill Technical Service, considered by many the most experienced in the field, can help you make the right selection for trouble-free operation.



MADE IN U.S.A. TO THE STANDARDS OF AMERICAN INDUSTRY

SCOVILL MANUFACTURING COMPANY

Mill Products Division, 99 Mill Street, Waterbury, Connecticut. Phone PLaza 4-1171

135C40

Check these improved
1960 insulations

you'll want them
in your new specifications

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BALDWIN-EHRET-HILL

Take a Fresh Look at **MONO-BLOCK®**

One Block Insulates up to 1800 F

B-E-H Mono-Block now spans the full range up to 1800 F; provides lower thermal conductivity, 0.63 at 800 F. Its long, spun mineral wool fibers form a strong, rigid block that stands abuse in handling — yet impales easily over studs or pins without pre-drilling, speeding application. Mono-Block provides an excellent surface for applying a single insulating-finishing coat of B-E-H Super Powerhouse Cement. This may be trowelled directly on the block — saving the expense of wire mesh and the time it takes to apply it.

Baldwin-Ehret-Hill has thrown a new light on insulation performance which will pay you well to consider in writing specifications. Continuing research and resulting product improvements meet advanced concepts in the design and engineering of new installations. You can depend on the B-E-H line of thirty specialized insulation products, for service from sub-zero to 1900 F, to give you better performance, easier application, and lower installed cost. To bring your specifications up to date, write for our 1960 catalog or see it in your Sweet's File.

NOW IS THE TIME TO UPDATE YOUR SPECIFICATIONS WITH . . .

BALDWIN-EHRET-HILL

100 Breunig Ave., Trenton 2, N. J. Incorporated • 1897

THE COMPLETE LINE OF INSULATIONS for use SUB-ZERO TO 1900 F.

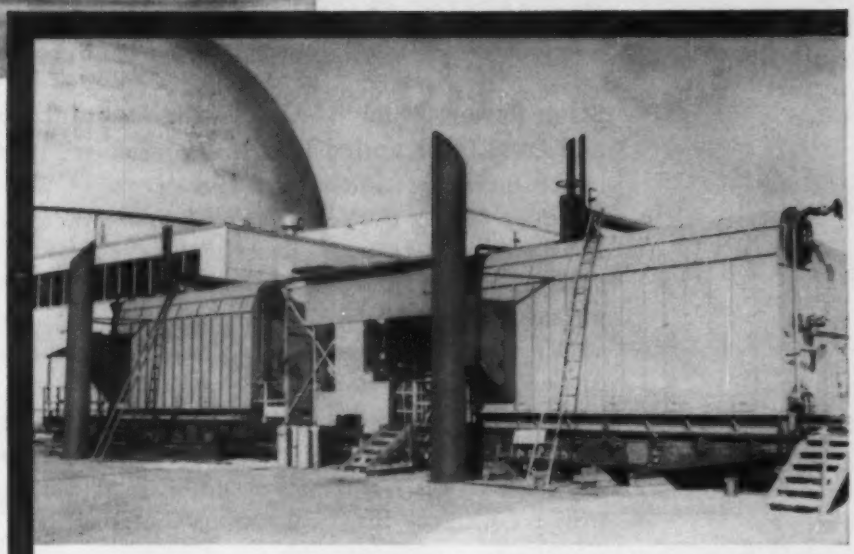
CONTRACT APPLICATION SERVICE FROM COAST TO COAST

STEAM-TESTED

with multi-purpose

KEELER dk

package steam generators



DRESDEN NUCLEAR POWER STATION
50 Miles Southwest of Chicago

— owner —
COMMONWEALTH EDISON CO.

— co-sponsor —
NUCLEAR POWER GROUP, INC.

designed and build by
GENERAL ELECTRIC CO.

Engineers-Constructors
BECHTEL CORPORATION

THE FIRST FULL SCALE privately financed ATOMIC POWER PLANT to go into operation in the United States.

Its power reactor is larger than any now operating or under construction in the country.

How do you check the nuclear unit steam lines and balance the turbine of an atomic power plant *without waiting* for the start-up of the entire Nuclear Reactor System?

This problem was solved quickly and economically at Dresden with *two Keeler Type DK Package Steam Generators.*

Two 55,000 lb/hr capacity Keeler DK's were fired-up five days after their arrival at the job site—*without removing them from railroad flat cars.* Fuel oil was piped direct to the burners through temporary underground lines from nearby tank cars. All conditions were otherwise arranged to simulate the eventual pattern of operation.

The two DK's were operated at capacities up to 68,000 lb/hr for considerable periods in the preliminary checking and later final testing of the plant's steam system, and balancing of the turbine.

Field reports indicated actual operating efficiency of the two Keeler units was *well above the 81.3% original guarantee*—in an application which ideally demonstrates the reason these DK units are described as *"multi-purpose steam generators"!*

Keeler is one of the nation's leading manufacturers of steam generators, with a complete line ranging from low cost package units up to 100,000 lb/hr and field erected units up to 200,000 lb/hr—for all fuels, all types of firing.

Nearly a century of versatility, economy and dependability are yours when you specify and insist upon Keeler Quality. *Write for full data...* there's a Keeler unit to efficiently serve your steam requirements.

— ESTABLISHED 1864 —

The Seal of Quality in Water Tube Steam Generators

Write For Bulletins

No. DK-2: Type DK Package Boilers
No. F-14: Type CP Boilers
No. M-2A: Type CPM Package Boilers
No. MK-1: Type MK Boilers

KEELER WATER TUBE Boilers

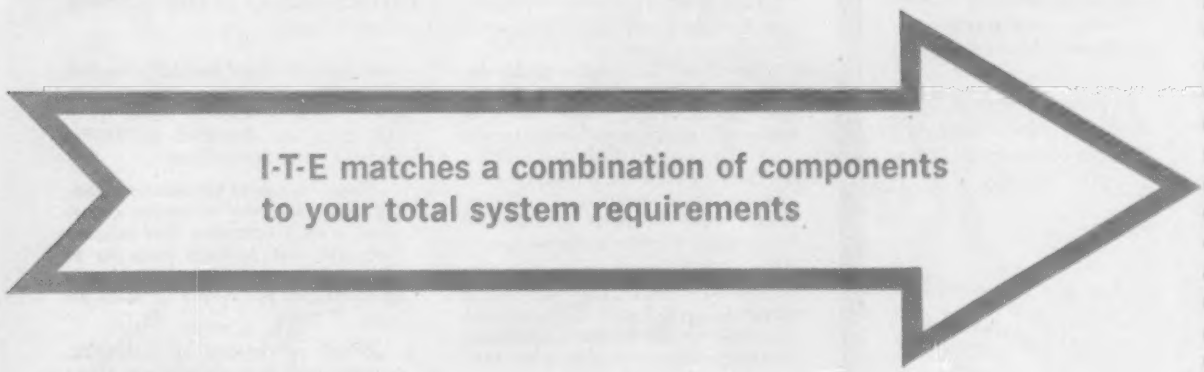
E. KEELER COMPANY
200-300 West St. • Williamsport, Penna.
— OFFICES IN PRINCIPAL CITIES —
In Canada: Canadian Vickers, Ltd., Montreal, P. Q.

For more facts circle 236 on Reader Service card, p 103

I-T-E's advanced fused interrupter switchgear with a Single Assembly Rating

Slash Power Switching Costs with Assurance of Safe Fault Closing and Long Interrupting Life. No longer do you need worry about individual component ratings for fused interrupter switchgear. With I-T-E's advanced Power Switching Centers you only concern yourself with specifying system conditions. I-T-E then *matches* a single assembly to your system requirements. You are assured of an integrated unit . . . switch, operating mechanism, fuse and housing . . . that will safely withstand the effects of *closing*, *carrying* and *interrupting* all values of current up to your system's specified short circuit capability (up to 600 amperes, continuous—and 500 mva short circuit capability).

Realize maximum economy where all the features of circuit breakers are not required. Prevent misapplication of protective equipment with I-T-E's Single Assembly Ratings. Get the complete story from your nearest I-T-E sales office or write I-T-E Circuit Breaker Company, Greensburg, Pa.

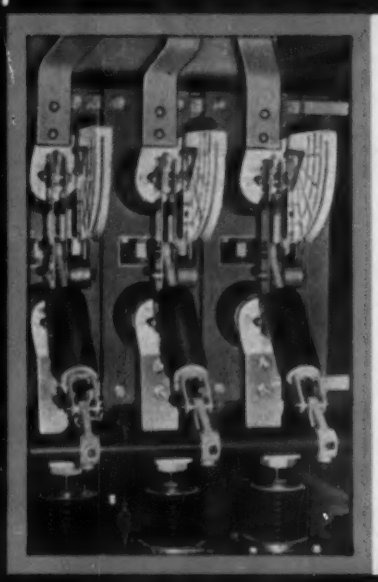


I-T-E CIRCUIT BREAKER COMPANY

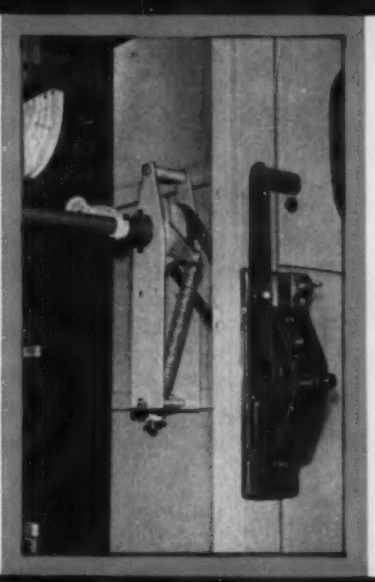
For more facts circle 237 on Reader Service card, p 103

Housing must withstand the effects of short circuits

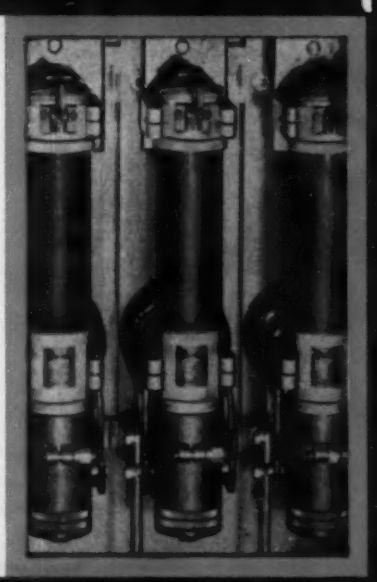
The LOWEST RATED Component Determines Total Fault Protection!



Switch must pass continuous load current and momentarily withstand fault current



Under fault conditions, the mechanism must positively close the switch and/or hold it closed against short circuit current



Fuse must pass continuous load current and interrupt fault current

Capitol PIPE SUPPLIES CHROME MOLY POWER PIPING

. . . for the new Philadelphia Electric 325,000 KW No. 1 unit at Eddystone generating station, which was designed for inlet steam conditions of 5015 PSIA at 1200° F. with two stages of reheat at 1050°F.

A large range of pipe sizes from ½" to 18" in standard to double extra heavy walls in grades 1¼%-2¼%-5% chrome were furnished by Capitol Pipe to the shop fabricator and the construction erector as well as to the turbine and boiler manufacturers.

It's our *Inventory Program* that enables us to meet today's power piping requirements.

Products of U. S. A. "Top Brand" manufacturers are your assurance of the highest quality.

Mill parity prices—large choice inventory—experienced management — qualified pipe sales personnel — are good reasons to BUY from CAPITOL.

Send for our Bulletin describing Capitol Chrome Moly Products, facilities and area of service.

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PIPE & STEEL PRODUCTS, INC.
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LO. 8-8288 • PHILADELPHIA 3, PENNSYLVANIA

For more facts circle 238 on Reader Service card, p 103

LOUIS N ROWLEY, EDITOR • JULY 1960 • ESTABLISHED 1882 **Power**

The critical years

These days I hear a lot of talk about the ease with which engineering graduates get jobs in industry, and even more about the "fabulous" salaries offered. Running through most of these comments is the general idea that the young engineer starting his first job really "has it made."

At the same time, several hundred commencement speakers have recently said, in one way or another, "graduation isn't the end, it's only the beginning." Hackneyed though this thought may be, it is everlastingly true—and pregnant with meaning for the fledgling engineer. He is entering the first and critical stage of his career—the early years that tend to set a pattern for those that follow.

Until that first full-time industrial job, the graduate has been following a pattern laid down by someone else. Now, whether he realizes it or not, he must set his own goals, plan his own program of professional growth. In most cases, industry will provide opportunity for development and there will be senior members of the profession ready with advice and counsel. But in the last analysis, responsibility for growth as a technical man, as an individual, and as a citizen rests with the young engineer himself.

To help meet the challenge of the critical early stages of an engineering career, the Engineers Council for Professional Development has fostered the "First Five Years" program. This aims to combat "post-college slump" in six key areas.

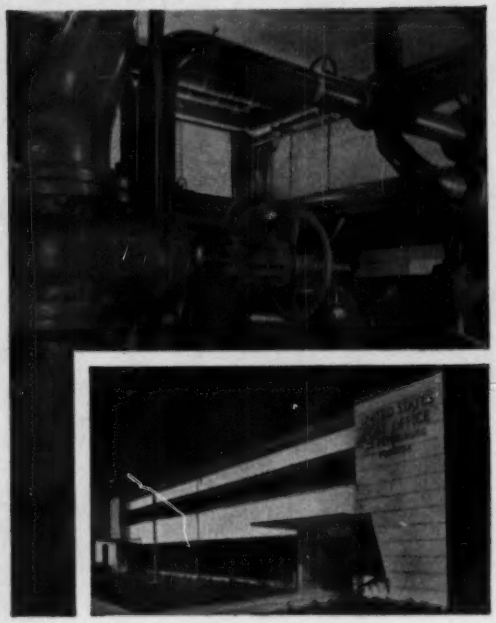
First, it alerts the embryo engineer to the importance of orienting himself in the new world of job and profession. Next it stresses the need for continuing education, the fact that for the professional man, learning never stops. And it provides guidance in a third area—the well-rounded reading program that develops ability to deal with men and affairs by absorbing the written experience of others.

Beyond these individual-centered elements, the "First Five Years" program builds a strong case for the young engineer's participation in professional groups and in community activities. Finally, the plan provides for self-appraisal at every stage of advance by demonstrating the necessity of self-knowledge and by showing how it may be obtained.

While the materials of this program are available for the individual use of young engineers, it operates most effectively as a community program, with the cooperation of industry, engineering societies and educational institutions.

Here is where you who read this can play a part. If the ECPD "First Five Years" program is already at work in your community, give it your full support, recommend it to the young engineers in your employ and of your acquaintance. And if there is no ECPD program operating, work through your company and your engineering society to get one started. For full information, write to Engineers' Council for Professional Development, 29 West 39th Street, New York 18, N. Y.

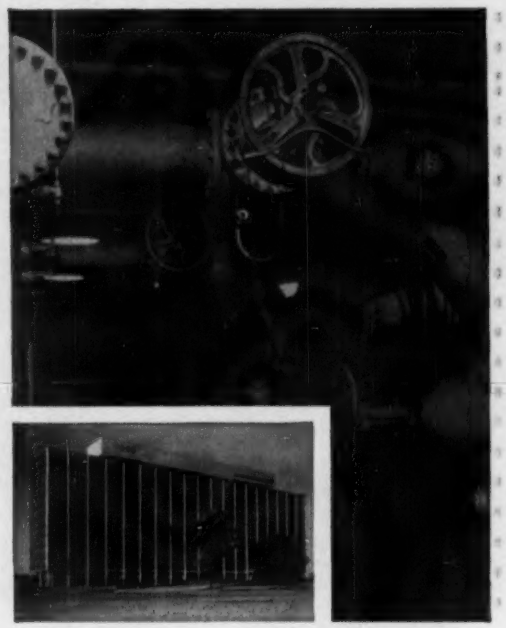
United States Post Office, St. Petersburg, Florida



IN AMERICA'S GREAT NEW BUILDINGS

Industrial, Commercial

YOU'LL FIND JENKINS VALVES

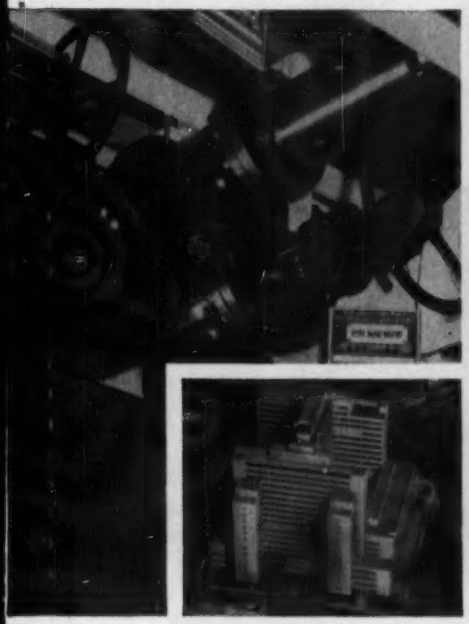


Ford Motor Company, Central Office Bldg., Dearborn, Mich.

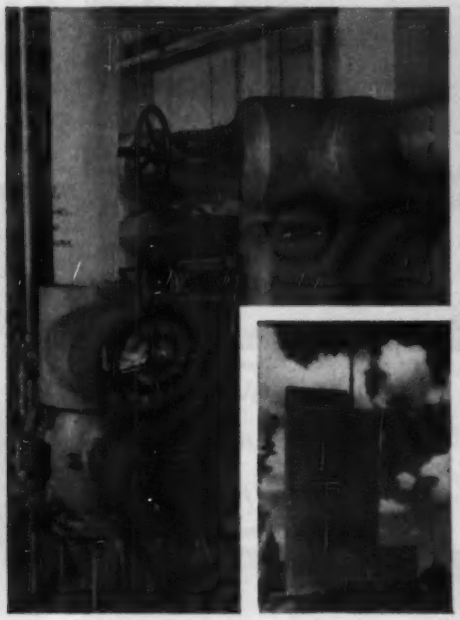
JENKINS®
Jenkins Bros

YOUR SPECIFICATION "JENKINS VALVES" IS BACKED BY THE JUDGMENT OF MANY OF THE COUNTRY'S

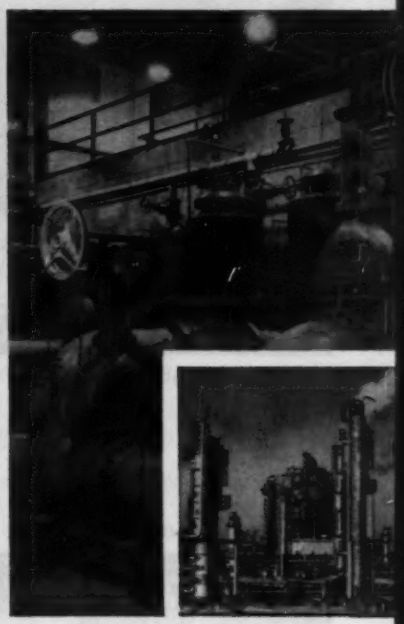
Grady Memorial Hospital, Atlanta, Georgia



The Prudential Insurance Company of America, Chicago.

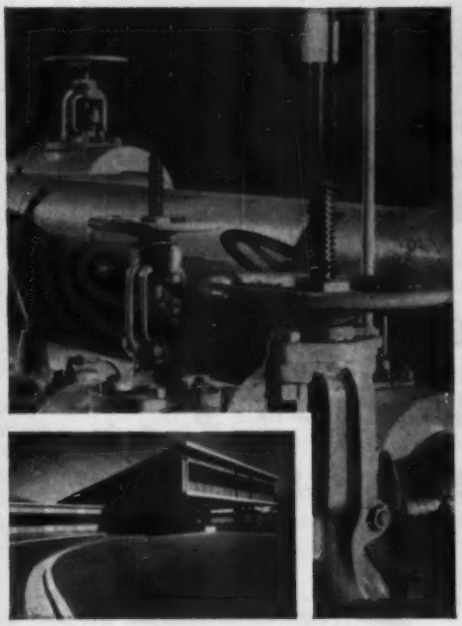


Tidewater Oil Company, Delaware Refinery



and Institutional

Chicago Sun-Times, Chicago, Illinois

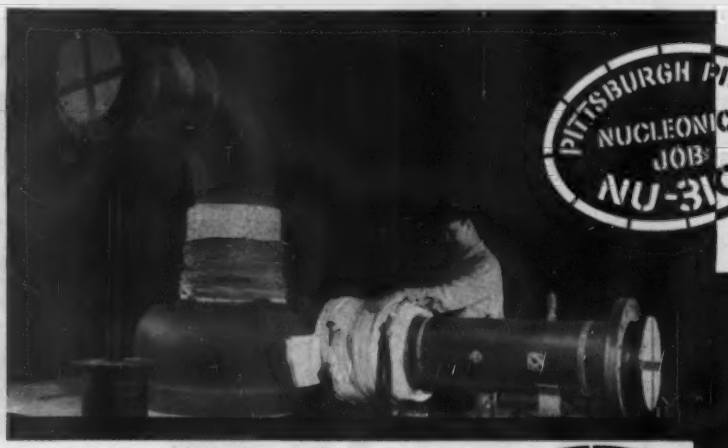


Bissell Inc., Grand Rapids, Michigan

The Interchurch Center, New York City

TOP ARCHITECTS, ENGINEERS, CONTRACTORS AND BUILDING OWNERS

For more facts circle 239 on Reader Service card, p 103



VOLUTE ASSEMBLY

STAINLESS STEEL LOOP

BULKHEAD PENETRATOR

Fabricated by Pittsburgh Piping for Nucleonics

These jobs demonstrate the variety of nucleonic piping work done in our shops. The volute assembly, shown in intermediate stage of manufacture, is fabricated of 14" and 16" Schedule 160 piping materials. The bulkhead penetrator, one of a group, is notable for an unusual method of welding dissimilar metals. The complex test loop requires skillful welding of stainless steel piping materials, and precise assembly of hundreds of components. We are equipped and staffed to do similar jobs for you. Telephone, or write and our representative will call. Or, we will be glad to have you visit our plant.

PIONEER FABRICATOR OF HIGH PRESSURE PIPING FOR NUCLEONICS

Pittsburgh Piping AND EQUIPMENT COMPANY
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New York..Woolworth Building

PP-40

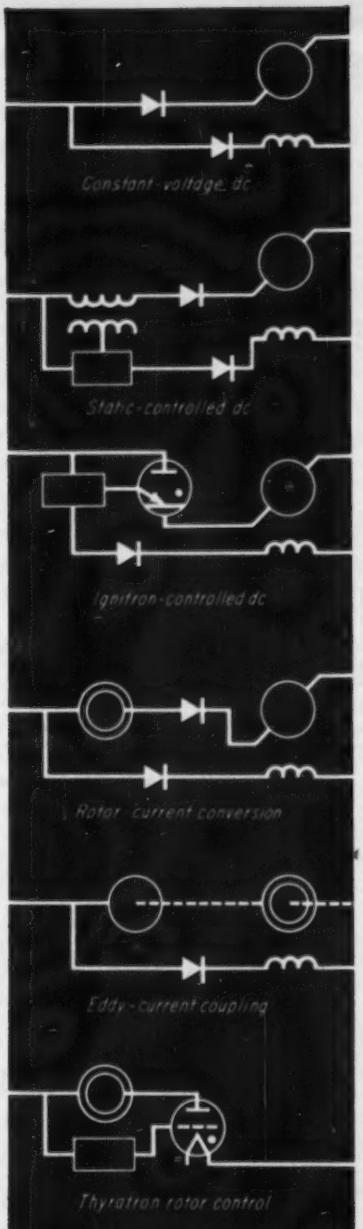
Design and equipment application section

B G A SKROTZKI
Associate Editor in Charge

Adjustable-speed drives match modern process needs

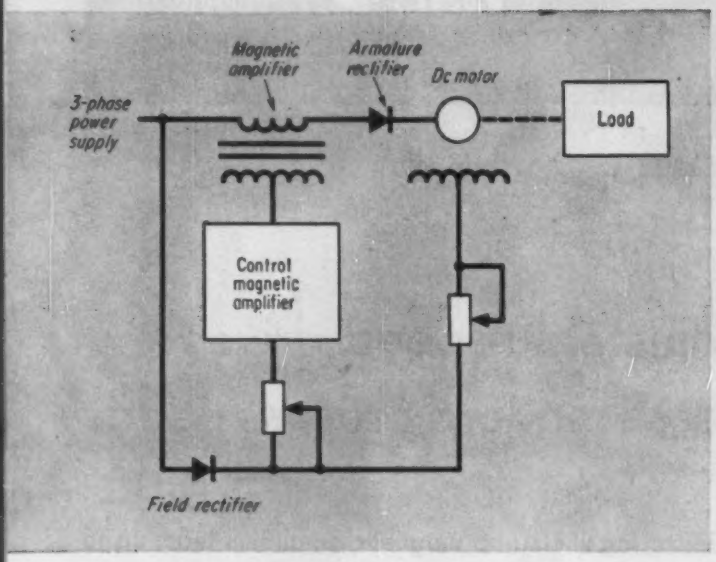
- Silicon rectifiers and magnetic amplifiers team up to give adjustable-voltage system new simplicity
- Eddy-current couplings integral with induction motors provide versatile drives finding many uses
- Semiconductor devices make recovery of rotor power loss practical while contributing to better overall characteristics
- Thyratron control of rotor current lets wound-rotor motor perform like a dc drive

By NORMAN PEACH, Associate Editor

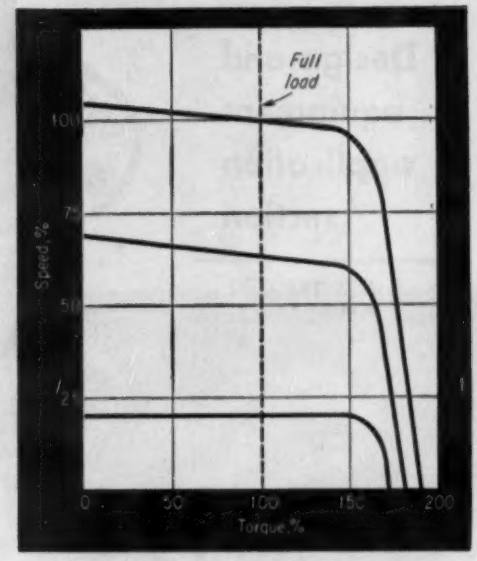


Complicated present-day industrial processes often demand adjustable speeds where an older process could get by with constant speed. Traditional applications of adjustable speed now require greater precision. What's more, many manufacturers like the convenience of being able to adjust production rate of machinery even when no speed change is needed in the production cycle. Trend has been on the upswing for ten years; drive engineers foresee still more industries taking up adjustable speed as they modernize their processes.

Today's thinking tends to run in terms of drives—motors, controls, transmissions—rather than motors alone. Packaged drives are coming in *big* packages, 500 hp or more. Advent of new drive components, principally silicon rectifiers and magnetic amplifiers, and improvements in older ones have substantially modified familiar drives and made practical others formerly experimental or suitable only for large, elaborate applications in certain specialized industries. continued



ADJUSTABLE VOLTAGE FOR ARMATURE is obtained with a magnetic amplifier and silicon rectifier. Separate rectifier, bottom, handles the field



SPEED-TORQUE CURVE for typical system with voltage regulation and compensation for IR drops

Dc motors are at heart of many adjustable speed systems today

An adjustable-speed motor, according to NEMA definition, "is one the speed of which can be varied over a considerable range, but when once adjusted remains practically unaffected by the load. . . ." These units are frequently called variable-speed motors, but the name may be confused with varying-speed motors which inherently alter their speed with changes in load, as does the series-dc motor. Conventional types of adjustable-speed motors, together with motor fundamentals, are discussed in a POWER reprint, *Today's Electric Motors*, June 1955.

Classic approach to adjustable-speed drive is a dc motor with adjustable-voltage power supply. Maximum speed range combines armature and field control. Since usual power supply is ac, first element of the drive is a converter. This may be a motor-generator set (Ward-Leonard system), rectifier or rectifier-magnetic-amplifier combination.

M-g sets, still the most widely used armature-control arrangement, are requisite for regenerative braking. Motor-armature voltage is adjusted by varying generator-field current. System is readily adapted to automatic speed regulation and has a fast response. Trend today is toward static regulators, though rotating amplifiers aren't out of the picture—they've been improved in recent years. But many control functions can be combined with the static regulator, including automatic acceleration and deceleration. Some designs incorporate transistors, and once these components are available in larger ratings they can be expected to play an important role.

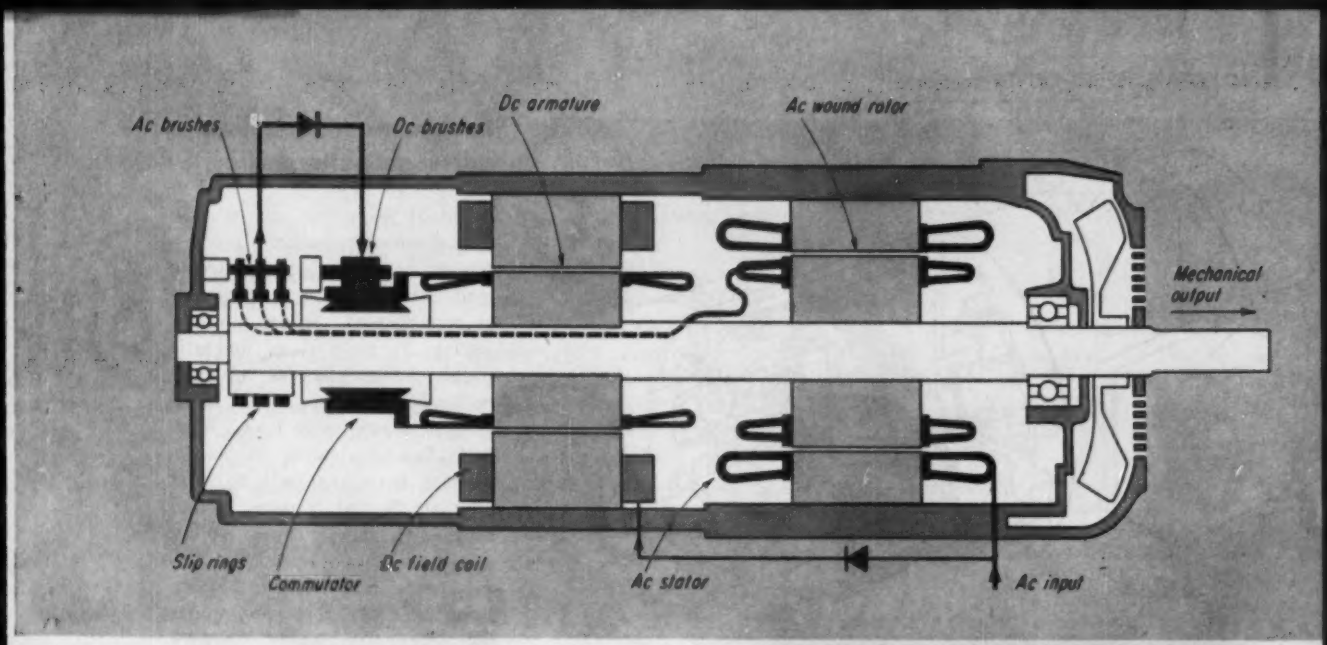
Electronic rectifiers with controlled firing have proved successful converters for dc drives (for info on rectifiers see POWER reprint, *Electrical Conversion*, Dec 1959). Armature voltage is adjusted by controlling tube's firing angle. Smaller sets use thyratrons, larger sets ignitrons—latter find wide acceptance in printing industry for large newspaper presses. Present-day tubes feature high reliability and low maintenance, or controls may use static components instead of tubes.

Silicon rectifiers, with long life, mechanical ruggedness and freedom from maintenance, are attractive as converters for dc drives. They aren't directly controllable in practical (integral-hp) power sizes, however. Recent improvements in saturable reactors allow use of magnetic-amplifier principle to control armature voltage, sketch, above left. Drive-conversion unit can be made completely of static components, so units can be about 25% smaller, 50% lighter than comparable m-g converters. Dc contactor and reduced-voltage ac starters are unnecessary. Overall system efficiency is high, 70 to 83%. A claimed advantage over tube converters: elimination of warmup time.

Silicon-controlled rectifiers may use methods similar to thyratron and ignitron control. They have all the advantages of static converters (POWER, Sept 1958, p 109). Today's cell is an expensive one, with power and voltage limitations. There is little doubt, however, that in a few years limitations will be overcome and silicon-controlled rectifiers will be leading converter for dc drives.

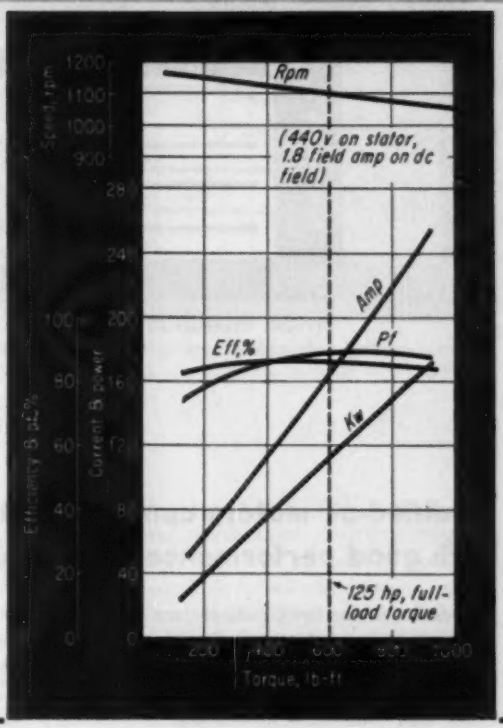
Constant voltage on armature with adjustable field current forms simplest dc drive. Speed ranges up to 4-1, constant hp, are obtained with field rheostats. These drives are ideal application for silicon rectifiers, with an autotransformer for suitable voltage. Low cost and minimum maintenance are possible where characteristics are satisfactory (see p 68).

De and ac motors are integrated on common shaft in recently intro-



AC-ROTOR CURRENT is converted to dc by external silicon rectifiers, then fed back to dc armature through commutator

OPERATING CHARACTERISTICS show high efficiency and power factor over wide speed-torque range for 125-hp unit →



Ac and dc motors work on same shaft

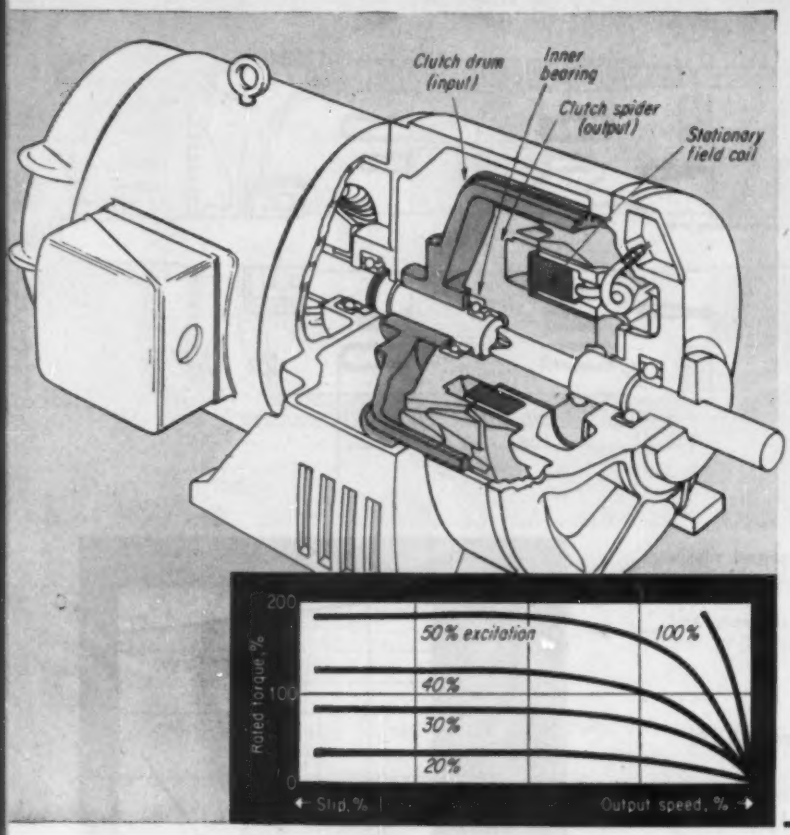
The dc motor generates a counter emf which bucks the rectified ac-rotor voltage. Difference between these voltages is such that rectified rotor voltage is just sufficient to circulate load current through ac rotor, rectifier and dc armature. If dc field is weakened, the counter emf decreases, allowing more current to flow. This produces more torque in both machines and drive accelerates to a higher speed. As speed increases, rotor slip voltage decreases while counter emf increases. Accordingly, acceleration ceases when these voltages differ by amount necessary to circulate running load current at the new speed.

Basic circuit can be modified in several ways. For example: regulators can be added in dc circuit to give performance similar to a typical dc motor.

duced design which has already proved successful — notably in machine-tool applications. Drive is based on Kramer principle, made practical by silicon rectifiers. Power losses of wound-rotor ac motor are recovered, speed stability with load variation is achieved. Basic circuit is shown in sketch above. Slip-frequency rotor current is taken out through slip rings, converted to dc by external rectifier and fed back through commutator. Field excitation is supplied by separate rectifier. Speed is adjusted by dc-field rheostat.

Drives are now available in 1½-1, 2-1 and 3-1 speed ranges, both constant hp and constant torque. Units of 7½ to 75 hp are integral as shown; larger units have motors coupled on common bedplate. Drives up to 60 hp can be started across the line (drawing five to six times full-load current) and simple reduced-voltage starting is applicable to larger hp ratings. Very smooth starts are obtained by exciting dc field at same time the ac contactor is closed. Time constant of field allows smooth torque buildup.

Basic drive operates over speed range with regulation of about 7½% and full-load efficiency of 80-85%, increasing with hp rating. **continued**



TYPICAL UNREGULATED torque-slip curves show capabilities of eddy-current coupling, speed substantially constant with regulator

Eddy-current coupling is adjustable-slip device

Standard ac motor drives cast-steel drum surrounding a pole assembly — spider — connected to load. Drum rotates continuously at motor speed. Spider has projections — teeth — of magnetic metal. A stationary dc toroid is enclosed by spider, spider being free to rotate with load. Magnetic flux originating in coil is directed by spider teeth to form alternate N and S poles around spider periphery. Since spider and drum always move at different speeds, magnetic flux passing through drum between spider poles changes in density. Changes in flux density produce eddy currents in drum which in turn set up secondary magnetic fields interacting with primary field of coil to develop torque between drum and spider. By controlling dc in coil, flux can be adjusted to produce desired slippage. Thus constant input speed yields adjustable speed at the output shaft.

Modified-ac motors combine adjustable speed with good performance characteristics

The desire to use comparatively simple squirrel-cage induction motors for adjustable-speed applications has led to growing popularity of combinations with eddy-current clutches or couplings. Several designs are available where motor and coupling are integrally mounted. Couplings can, of course, be separate units, and this is usually the case in the larger sizes or where synchronous motors are used. Eddy-current coupling is described above. It uses no brushes or slip rings; a silicon rectifier supplies field dc. Field is easily controlled by static regulator and speed can be kept stable at any setting in ranges as wide as 34-1. With speed regulator, regulation can be as fine as 2%.

Power losses take place in the drum where eddy currents circulate. Power is dissipated in form of heat. In air-cooled units drum has fins; drum rotates at constant speed, providing a constant flow of cooling air. Large or enclosed units are water cooled. In these units losses rapidly increase as lower end of speed range is approached, but because most loads are driven at speeds above 70%, average efficiency is comparable to other drives—80 to 85%. At upper end of speed range, efficiency may run as high as 92 to 96%.

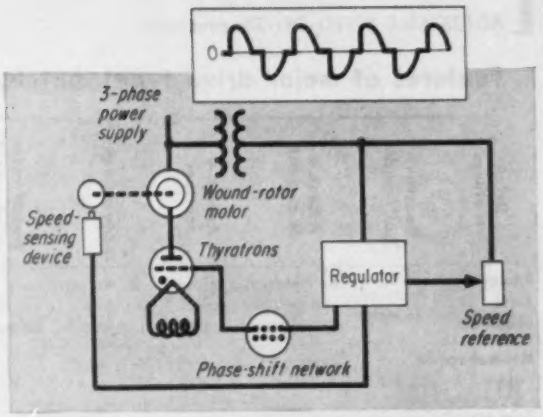
Torque transmitted by eddy-current coupling is proportional to excitation of primary field, and within limits, to slip. Coupling excitation is adjusted so that coupling torque and load torque are equal at the desired operating speed. Any change in load torque requires a compensating change in excitation to maintain constant output speed. Design assumes that the input motor is capable of producing whatever torque is demanded by the load.

Drives are adaptable to many kinds of control, including tachometer feedback. Motor can be brought up to speed before load is connected, and on-off functions as well as jogging can be performed by the coupling. Adjustable time acceleration to operating speed with either a logarithmic or linear rate can be provided. Some constructions provide for the addition of an eddy-current brake where dynamic braking is desired.

Variable-frequency ac utilizing synchronous induction motors is practical today for applications where several motors must run at the same speed and have simultaneous speed

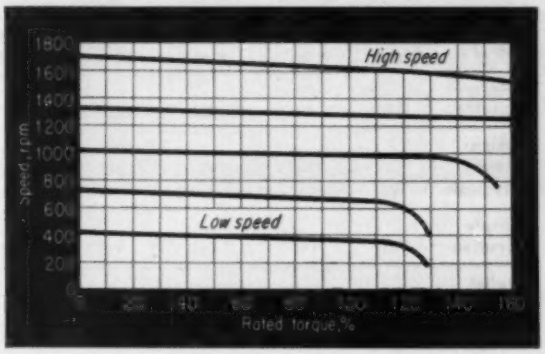
Thyratrons in secondary control the speed of wound-rotor induction motor

Secondary 3-phase circuit is closed through six thyratrons. For maximum speed, thyratron's firing angle is set so that full sine wave of voltage appears. Condition is equivalent to shorting all resistance on highest step of conventional wound-rotor motor. Instead of inserting resistance to obtain lower speeds, tube's firing angle is retarded so that only part of sine wave appears and rotor current is reduced. As speed approaches speed reference setting, regulator controls tube current, hence motor torque, and motor develops only enough torque to drive the load at the desired speed.



CONTROL CIRCUIT (all thyratrons represented by a single tube) shows how tubes control secondary current of induction motor. The closed-loop circuit compares reference voltage selected by operator with output voltage of speed-sensing device connected to motor

SELF-DRIVEN FAN mounts on its own bearings and changes speed as load changes. At high speed and no load fan turns slowly, at low speed and high load it turns rapidly. Inductor ring passes between stator- and rotor-coil extensions and is driven by leakage flux. Latter is proportional to current in coils, and so is rpm of fan



SPEED-TORQUE CURVES of drive with current-limiting feature show large droop in speed only at excess overload at low speeds

adjustments. One ac generator supplies all the motors, output frequency of generator being determined by driven speed of generator. Generator is driven by a 60-cycle squirrel-cage motor with mechanical adjustable-speed drive interposed, or by the eddy-current drive just described. Applications include multiunit conveyors, textile and paper printing, synthetic-fiber spinning. Standard speed regulation of these systems is 6%, but a special regulator can bring it down to 0.1%. Continuous-duty speed ranges (constant torque) have an 8-1 maximum.

Other approaches to variable frequency involve converters. Proposals for drives using magnetic frequency multipliers have yet to be developed into a commercially available product. Drawbacks: wave forms aren't truly sinusoidal, number of frequencies is limited and converters are expensive to build. A converter based on transistors or silicon-controlled rectifiers, which some engineers believe is the ultimate answer to ac adjustable-speed drives, awaits the further development of these components.

Incidentally, some applications (refrigeration is one) point to need for induction motors at higher speeds than those obtainable at 60 cycles, and are spurring h-f research.

Secondary control of wound-rotor motor by thyratrons has proved a successful way to obtain adjustable speed with good performance characteristics, above. Drive involves a regulator and speed-sensing device, called a tachometer generator. Speed range from standstill to motor's maximum (1650 rpm for 4-pole machines) has a normal regulation of ± 3%. Jogging and creeping are accomplished by secondary control.

Motor is essentially a standard wound-rotor unit, with typical inertia, power factor, starting torque and so on. It is practical to operate at much lower speeds, however, and in order to get proper cooling a unique self-driven fan is included in the design, described above. Thyratrons are conservatively applied; failure of one or more tubes will not make the drive inoperable or create dangerous conditions. Drives are now available up to 100 hp and larger ratings have been built for special applications. Smooth acceleration and deceleration have made thyratron-secondary-controlled drives attractive in many industries, especially textiles, paper and film, as well as for elevators and conveyors.

Principle of secondary control isn't necessarily limited to thyratrons, though these tubes are used today. Silicon-controlled rectifiers may eventually enter this area, too. **continued**

Features of major drive types match job demands

Drive features	Drive types: Constant-voltage dc	Adjust.-v dc m-g set	Adjust.-v rectifier	Eddy-current clutch	Wound-rotor ac, standard	Wound-rotor thyratron	Wound-rotor dc-motor set
Power units required	Rectifier, dc motor	Ac motor, dc gen, dc motor	Rectifier, reactor[1], dc motor	Ac motor, eddy-current clutch	Ac motor	Ac motor, thyratrons	Ac motor, dc motor, rectifier
Normal speed range	4-1	8-1 c-t+ 4-1 c-hp[2]	8-1 c-t+ 4-1 c-hp[2]	34-1, 2 pole, 17-1, 4 pole	3-1	10-1[2]	3-1
Low speed for jogging	No[3]	Yes	Yes	Yes	Yes	Yes	Yes
Torque available	c-hp	c-t	c-t	c-t	c-t	c-t	c-t, c-hp
Speed regulation	10-15%	5% with regulator	5% with regulator	2% with regulator	Poor	± 3%	5-7½%
Speed control	Field rheostat	Rheostats or pots	Rheostats or pots	Rheostats or pots	Steps, power contactors	Rheostats or pots	Rheostats or pots
Enclosures available	All	All	All	Open[4]	All	All	All
Braking:							
Regen	No	Yes	No	No	Yes	Yes	No
Dynamic	Yes	Yes	Yes	No[5]	Yes	Yes	Yes
Multiple operation	Yes	Yes	Yes	Yes	Yes	Yes	No
Parallel operation	Yes	Yes	Yes	Yes	No	Yes	Yes
Controlled accel, decel	Yes	Yes	Yes	Yes	No	Yes	No
Efficiency	80-85%	63-73%	70-80%	80-85%	80-85%	80-85%	80-85%
Top speed at max torque	83-87%	60-67%	60-70%	29%	29%	85-90%	73-78%
Rotor inertia[6]	100%[7]	100%	100%	75%	90%	90%	175%
Starting torque	200-300%	200-300%	200-300%	200-300%	200%	200-300%	200-300%
No. of comm. rings	1 comm	2 comm	1 comm	None	1 set rings	1 set rings	1 comm, 1 set rings

c-t = constant-torque; c-hp = constant horsepower. (1) Used only in saturable-reactor designs (2) Units of 200-1 speed range are available (3) Low speed can be obtained using armature resistance (4) Totally enclosed units must be water or oil cooled (5) Eddy-current brake may be integral with unit (6) Based on standard dc motor (7) Normally is a larger dc motor since it has slower base speed

Selecting the proper drive for your machine from today's wide selection of adjustable-speed designs may appear a difficult assignment. Generally, these points have to be considered: (1) functional requirements (2) initial cost (3) maintenance (4) availability (5) operating costs. This is probably the usual order of importance, with balancing of function's value against its cost the major decision. Some industries, such as paper, are acutely aware of their needs; others may find it difficult to evaluate a drive function. Adding some special feature may make the process more profitable. On the other hand, specifying performance not actually demanded (perhaps regulation more precise than needed) adds unnecessarily to cost of drive. Features often required of drives are in table.

Maintenance is usually an important consideration, but training and attitude of maintenance personnel is as weighty a factor as equipment design. Men accustomed to care of rotating machines may have little or no trouble with commutators, but feel uneasy with electron tubes.

In this report we have discussed only recently developed or significantly modified drives. Familiar methods, where applicable, must be considered—standard wound-rotor motors, multispeed (pole-changing) motors and cascading of motors. Designs, like the Schrage machines, involving ac commutators, have lost popularity in the United States in recent years but are still made in Europe.

Looking into the future a little way, most drive engineers expect great things of the silicon-controlled rectifier when cost and ratings reach practical magnitudes. Recovery of rotor losses not as dc but as ac of line frequency is one possibility. Variable frequency from static converter is another. And perhaps at last a dc motor without commutator!

Two "future" adjustable-speed motors have already appeared, but have not had practical application as yet. One of these is the "spherical" cage induction motor designed in Great Britain and described in POWER, Jan 1959, pp 78-79. In this design, speed change is affected by mechanically shifting the axis of stator relative to axis of rotor. Efficiency is high; brushes, commutator or slip rings are not required. It looks, however, as if the cores would be expensive to build and wind, and response to speed changes, since effected mechanically, would be relatively slow. A British firm is now constructing a 200-hp machine for commercial use. Development to shift the fluxes electrically is presently under way.

Second technique is now applicable to small motors—found in hand tools. Reactor-capacitor circuit used with universal motor produces 5-7% regulation drive, contrasting with normal 50%, from no load to full load. Speed adjustment is accomplished by a variable autotransformer in circuit.

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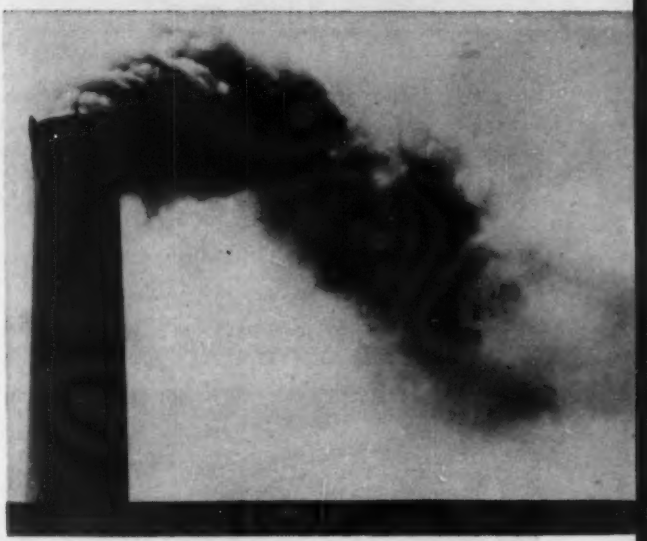
Knowing your fuel's characteristics is a major step toward . . .

Solving your air pollution problem

By GREGORY GOULD, President
Fuel Engineering Co of N.Y.



LARGE-DIAMETER stack tends to intensify appearance of plume, but heavy smoke can almost always be traced to poor combustion

Over 50% of the population of the United States is concentrated in approximately 1½% of the land area. Such a concentration of human beings would not be possible if their survival depended upon human and animal muscle power. Unlocking the vast store of chemical energy in our fossil fuels has been a major part of the foundation of this social and economic complex. Paradoxically, it has created one of our most pressing problems — atmospheric pollution. Key to the lock of our chemical-energy storehouse is the mechanism of combustion, and there can be no doubt that combustion processes are a major pollution source.

Combustion processes for industrial-steam-plant operation involve use of such fuels as coal, oil, gas and waste products. Let's take a brief look at their typical analyses, then see how their characteristics contribute to atmospheric pollution.

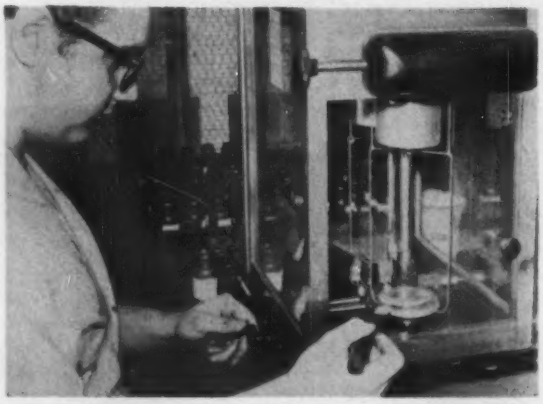
Coal. Most extensively exploited coals used industrially are the anthracites and bituminous of Eastern and interior origin. Coal isn't a single substance; it exhibits infinite chemical and physical properties. Bituminous coal is by far the major source of industrial energy and its range of typical analyses shows: moisture, 2 to 15%; volatile, 14 to 40%; ash, 4 to 15%; sulfur, 0.5 to 4.5%; Btu per lb, 11,000 to 14,000. Currently we're using about 450-million tons per year.

Anthracite's range of typical analyses shows: moisture, 4 to 10%; volatile, 4 to 8½%; ash, 7 to 20%; sulfur, 0.4 to 0.8% and Btu per lb, 11,000 to 13,500. Only smaller sizes are used on mechanical equipment for industrial steam generation. Despite many favorable characteristics from an air-pollution standpoint, anthracite isn't widely used: it isn't competitive with bituminous very far outside the immediate mining area. Production has been decreasing for years and it's presently only of minor importance as an industrial fuel. Current industrial consumption is about 6-million tons per year.

Oil. With minor exceptions the only petroleum product used as industrial steam fuel is the heavy residual, known as No.-6 grade or Bunker C, from refining operations. It contains a concentration of most of the crude's impurities, has high carbon, twice the hydrogen content of high-volatile bituminous coal, and makes a satisfactory industrial boiler fuel which is priced to compete with bituminous in many areas. Typical No.-6 grade fuel-oil analyses range shows: API gravity, 8 to 16; viscosity, 28 to 310 ssf at 122 F; flash point, 150 to 300; bottom sediment and water, 0.2 to 1.5%; sulfur, 0.5 to 4.0%; ash, 0.01 to 0.5%; vanadium, 10 to 350 ppm; Btu per lb, 18,000 to 18,800.

Gas. Today, natural-origin gas is the most widely used gas fuel for industrial steam generation and process furnaces such as those used for glass manufacture. It consists principally of methane with small amounts of ethane, propane and nitrogen and trace amounts of other gases and substances. As distributed for fuel consumption it usually has negligible sulfur content and thus, so far as the struggle against air pollution is concerned, is of little concern.

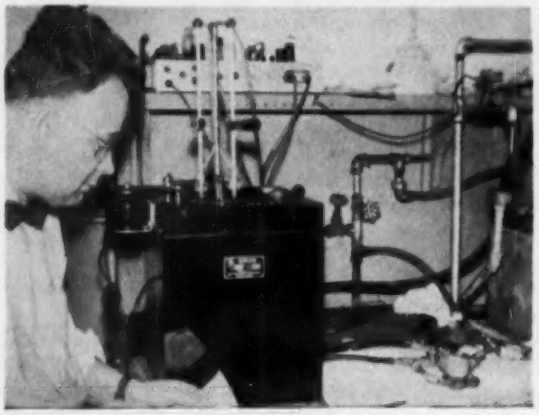
Waste products — wood chips,



DELICATE analytical balances are used in weighing laboratory portions of coal slated for chemical and physical determinations

FUEL-OIL SAMPLES, shown coded and ready for laboratory analysis, are important in determining oil's air-pollution potential

VISCOSITY of fuel oil must be known. This property determines oil temperature needed to provide best possible atomization



ACTUAL COMBUSTION in a calorimeter to determine amount of chemical energy stored in fuel is another preview of characteristics

Poor combustion is still the major source of air pollution

plastics, black liquor and various chemical byproducts—are not a major source of industrial energy but are likely to create local air-pollution problems peculiar to themselves. We'll confine our discussion to the general problems arising from use of the more common industrial-plant fuels.

Pollutants from industrial steam plants include smoke and fumes, fly-ash, various gases and organic vapors and acid mists. Two basic techniques are used singly or in combination to abate these pollutants: minimize their formation; minimize discharge of those that form. Successful practical application of these is a function of: (1) fuel characteristics (2) plant characteristics and design (3) relative economics of all available fuels (4) characteristics of the pollutants and (5) economics, space requirements and operating principles of suitable abatement devices.

Chemical and physical characteristics of the fuels have an important bearing on formation of air pollutants. This is pointed up by the fact that many smoke-abatement ordinances limit coal's volatile content. An understanding of this and how fuels' other characteristics affect pollutant formation is a must if we're to come up with economical and effective control.

Heating value. Amount of chemical energy stored in fuel relative to impurities such as sulfur determines volume of these impurities which must be fed with the fuel to generate a given amount of steam or hot water. Residual-oil heating-value variations cover a range of about 4½%, of minor significance in air-pollution potential. Same is true of gas, which contains substantially no impurities of this sort. But variation of heating values in coals *is* significant. Btu range of bituminous, mentioned earlier, represents roughly a 25% variation. It's evident that a 2%-sulfur coal, 11,000 Btu per lb as fired, would potentially contribute about 27.5% more sulfur to air pollution than a 2% sulfur, 14,000 Btu per lb coal provided both were converted at the same efficiency to generate the same amount of steam. Even more dramatic: an 11,000-Btu coal with 4%

sulfur would contribute potentially *five* times as much sulfur to air pollution as a 1%-sulfur 14,000-Btu coal. Similar relationships hold for ash content.

Sulfur in coal occurs as pyrites (iron sulfide), organic compounds and sulfates. Pyrites and the organic forms constitute most of the sulfur; sulfates (mostly as gypsum-calcium sulfate) account for only small amounts. Sulfur in fuel oil usually exists as mercaptans, sulfides and disulfides. The mercaptans are characteristically odorous, though in oil they don't usually create any odor nuisance. Commercial-grade natural gas generally contains less than 0.15% sulfur which occurs as hydrogen sulfide. All these substances either oxidize or tend to decompose at furnace temperatures to release SO_2, metal oxides and small amounts of SO_3. Usually 1 to 5% of total sulfur in the fuel converts to SO_3 in the combustion process.

Sulfur dioxide is an obnoxious and irritating heavy gas, over twice as heavy as air, which will modify respiratory patterns in concentrations as low as one ppm, has an odor threshold at two ppm. Sulfur trioxide hydrates to sulfuric acid with moisture in the air. This acid mist will modify respiratory patterns at from 0.3 to 0.5 ppm, may be detected by some people at one ppm, becomes irritating and objectionable at about three ppm. Sulfuric-acid mist in stack gases produces a very dense, lingering white "smoke" even in very small quantities.

A pulverized-coal-fired boiler burning a 4%-sulfur coal at 14% CO_2 may produce a concentration of about 2500-ppm SO_2 by weight in the flue gases, assuming that 90% of the sulfur appears there as SO_2. Stoichiometric relationships are such that an oil-fired boiler burning a 4%-sulfur oil at 14% CO_2 would cause a concentration of about 2200 ppm in the flue gases—although more sulfur will find its way into the flue gases from an oil-fired boiler than from a coal-fired unit. Further, because oil has more Btu per lb than coal, a 4%-sulfur oil introduces less sulfur into the system than a 4%-sulfur coal if each is generating the same amount of steam. Stoker-fired plants discharge from 60 to 75% of the sulfur from the stack as SO_2 while in pulverized-coal-fired plants discharge may run as high as 95%.

Moisture, on the as-fired basis, displaces an amount of combustible equal to its own weight. It reduces the fuel's heating value in direct proportion. Total loss may be up to 150 Btu per lb of as-fired coal for each 1% moisture. While this amount seems minor, moisture's effect on air-pollution potential is insidious. Affecting coal's handling and grinding properties, moisture can disrupt flow to furnace, upset combustion, cause heavy smoking. Pulverizer-mill capacity is reduced as moisture increases. If moisture is excessively high, efforts to get enough coal to carry the load may result in mill adjustments which reduce fineness of delivered coal. This can up flyash discharge.

Volatile. Visible airborne pollution resulting from a smoking stack is so obvious that it was the first form of air pollution to be recognized as such. It has long been known that some relationship exists between fuel's volatile content and smoke. Roughly, the higher the volatile content, the greater the coal's smoke-producing potential. Recent research indicates that we may be developing a sound scientific explanation of smoke formation and ways to measure smoke-producing potentials of our coals.

Incomplete combustion, we know, causes smoking. While we may think of the combustion process as instantaneous, what actually happens is a complex sequence of reactions resulting finally in CO_2 and water. If complete combustion isn't possible, hydrocarbon molecules may decompose to carbon and hydrogen. This form of solid carbon is finely divided (from ½ micron down to possibly 1/1000 micron) and the particles tend to agglomerate, leaving the stack as black smoke. Particles are practically noncombustible and once formed are almost sure to escape unburned.

We're all familiar with the "three T's" (Time, Temperature, Turbulence) necessary for good combustion. However, boiler design economics demand shortest possible residence time in the furnace to keep sizes down to manageable proportions. Thus we should do everything possible to promote rapid complete combustion or even the best coal will produce smoke.

Flyash generally comes first to mind in connection with air pollution. It's somewhat of a misnomer because flyash contains varying amounts of carbon as well as the mineral noncombustibles. Depending upon firing method and other factors, amount may range from negligible proportions of ash in coal to over 80%. But we can safely say that, regardless of firing method, higher ash content means higher air-pollution potential.

Grindability index is a measure of how easily a coal may be pulverized. The finer the particles, the more rapidly they will burn completely. Any sacrifice of fineness increases air-pollution potential.

Coal dust pollutes the air as much as any other dust and can be a problem around coal-handling and storage areas. Here fines develop, quantity depending on coal friability. Fines dictate amount of dust control necessary, which can be done by wetting or treating with oil or chemicals.

Size consist affects flyash produced by stoker-fired units, particularly with spreader stokers which are designed to burn fines in suspension. As quantity of fines increases so does amount of flyash produced.

Viscosity - temperature characteristics of fuel oil, which can vary widely, determine temperature needed for good atomization. Without this we can't have good combustion; result will be smoke.

Bottom sediment and water in fuel can cause air pollution in somewhat the same manner as moisture and ash in coal. Popular misconception tags bottom sediment as foreign material that has found its way into the oil through neglect. True, there is some of this, but main content of bottom sediment is emulsions, polymerized hydrocarbons, gums, resins and other products of chemical reactions within the oil. Sediment fouls strainers and burner tips, chokes oil supply to burner. Result: poor atomization, smoke. Water, objectionable because of its adverse effect on combustion-equipment performance, may arrive at the burner in slugs, cause unstable flame, upset good combustion which again means smoke.

Next month Part II of this discussion goes into the effect of plant characteristics and design, pollutant characteristics and air-pollution control-equipment costs.

Energy systems engineering and the metric system

Does the metric system offer a sure cure for our mathematical troubles? Or are there better methods to choose?

By THEODORE BAUMEISTER, Consulting Engineer
Stevens Professor of Mechanical Engineering
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Advent of atomic energy in the work of the energy-systems engineer has given him new mongrelized units for measuring performance. Things were bad enough before, but now they verge on the intolerable.

For many years efforts have been made to eliminate *boiler horsepower* from our vocabulary as a measure of boiler capacity or output. POWER recently stirred up discussion of the subject—but without much success. Many people find boiler horsepower useful, so we can't eliminate the term.

The current preference for reheat cycles as standard practice in central stations makes the alternative term *lb steam per hr* of as little value as boiler horsepower. When one-third of the heat is added through the reheater, lb per hr has little, if any, meaning. In fact, many central-station people talk of boiler capacities in *kilowatts!*

Kilowatts of what?

This means kw of an associated turbine-generator plant supplied with steam from and reheated in the boiler. As such, the term *kilowatt* is simply the glorified 1960 edition of the old boiler horsepower. Kilowatt has no significance for the usual industrial power plant with its demands for process steam.

To thicken the stew, along comes the nuclear specialist trying to sell us a power reactor. When it's time to specify the rating and measure the reactor heat output, what does he use for units? Not *Btu per hr* or *lb steam per hr*, but *kilowatts* or *megawatts*. But these are not the kilowatts the older energy-systems engineer has in mind; these are *thermal kilowatts*—measured as heat output of the reactor.

The nuclear man uses kilowatt to mean any energy rate with respect to time—whether it applies to thermal, mechanical, chemical, electrical, nuclear or any other form of energy. This avoids the confusion of using ft-lb per min here or Btu per hr there or ergs per sec elsewhere. Just one universal unit for measuring power—the kilowatt.

This is good, but the user of the term must be certain that his listener or reader is not confused. In a nuclear-electric-power plant he must clearly distinguish between thermal kilowatts and electrical kilowatts. And so we get a new form of confusion and symbols such as *t kw* and *e kw*, or *kw*(*t*) and *kw*(*e*). [EDITOR'S NOTE: POWER uses *kwt* and *kwe*.] With these terms we have come just about full circle and are back where we started. We now have the 1960 edition of boiler horsepower—the kilowatt (thermal) and the megawatt (thermal).

Confusion compounded

Nuclear engineering has introduced another monster. Look at any reactor report or specification and you'll find the most horrible conglomeration of terms and units. Core loadings will be expressed in kilograms, price of uranium will be in $ per gram and heavy water in $ per lb, temperatures on one item will be in C and on the next in F, pressures will be in psi, speed of an associated ship in knots, burnup will be in *megawatt-days per ton*. At this point many engineers are sunk because they don't know whether the ton is short, long or metric.

When you get right down to it, megawatt days per ton is like calorific value of ordinary fuels so why not say Btu per lb or calories per kg? But that would not be scientific—Btu and calorie have long been relegated to the scientific junk pile. They can no longer be defined in terms of raising a unit mass of water one degree. The definition must be based on the agreed international electrical standards so that a Btu is 251.996 calories and a calorie is 1/860th of a watthour. Any other definition is to be marked "obsolete" in the rule book.

This glorification of the kilowatt-hour (megawatt-hour) as the unit of energy and the kilowatt (megawatt) as the unit of power is commendable. But while it gives some accurate relations it still leaves much to be desired. Confusion remains in interpretation and meaning. Cumbersome thermal kilowatts or electrical kwhr have to be used to make certain of minimizing misunderstandings.

Why the English system of units?

All of this raises the question: why do American engineers continue to use the ft-lb-sec system of units when the metric system has such obvious merits? American engineers must come to the use of metric units if they are to understand the language of the nuclear scientist, atomic physicist and theoretical chemist, who collec-

*Editor of Marks' Mechanical Engineers' Handbook

tively have demonstrated the feasibility of nuclear fission. Units of measurement with these people, as in all pure science, are metric.

The American engineer would benefit in many ways by adopting the metric system. He would be using the accepted standards of much of the rest of the world. Data would be more easily understood because unit conversions would be reduced. The system of units would be tailored to the system of counting. A system of weights and measures that conforms to counting tables by moving a decimal point has tremendous appeal. Compatibility of the metric system with international standards, however, should not be construed as a palliative for all ills of measurement. There are aspects the practical engineer should not overlook when considering the metric system.

Take a hard look

Technically the metric system has only one basic merit: it conforms to the counting tables where the decimal point moves when multiplying by ten. If the "decimal" moved when multiplying by eight or twelve, the metric system would be just as awkward as the ft-lb-sec system or the systems used by the ancient Egyptians, Incas or Malays.

In the days when counting must have been done on the fingers, the convention of moving the decimal point when multiplying by ten was natural and convenient. Some people feel that moving the decimal point when multiplying by ten is providential dictation. Many engineers, however, today deal with computing machines in which the binary system uses only two symbols.

Excellent counting tables can be devised where the "decimal" point moves when multiplying by eight or twelve. The former gives easily learned counting tables. Every schoolboy knows the difficulty of the nines table. If the decimal point were moved when multiplying by eight, two symbols could be dropped and the poor schoolboy would only have to struggle to 7×7 and thereafter move the decimal point.

Moving the decimal point when multiplying by twelve is inherent in the fascinating duodecimal system. Two extra symbols must be added, making the counting tables harder to memorize. Twelve or a dozen is a unique unit because it can be divided accurately into two, three, four or six equal parts. The ten system can only be divided into two or five parts and the eight system is limited to two or four parts.

Dividing into two equal parts had a profound influence on the world's system of weights and measures. A length of rope, a bucket of water or a wheelbarrow of coal can be divided into two equal parts without using any standard lengths, volumes or weights. Dividing can be carried on by dividing each part into halves and so on to give quarters, eighths, sixteenths, thirty-secondths, etc.

This is doubtless the background of the usual fractions of an inch, the sixteen ounces to the pound, the two pints to the quart and the four quarts to the gallon. If you were asked to divide anything into tenths you would proceed to cut it into two equal parts, but from there you would be on your own in trying to divide each half into five equal parts. If you don't think this is nigh hopeless try it sometime with draftsman's divides or a weighing scale without standard weights. Dividing into three parts is similarly disheartening.

The easy counting system where the decimal point moves when multiplying or dividing by eight has real merit. For a homely example of this process watch a housewife cut a pie—she won't use any system except to cut it in half, then quarters, then eighths.

The metric countries offer weird realities by selling eggs and rolls by the dozen; a case of wine or champagne contains twelve bottles. Any worthy engineer will speculate on the significance of such realities. Despite the machinations of learned people, the merchant, the salesman or the ordinary man still finds it best to deal with common or vulgar fractions and prefers the dozen, though he has no knowledge of the duodecimal system.

Metric system no panacea

Adopting the metric system would not free us of many cumbersome figures. No one has seriously proposed changing the ancient methods of measuring time with the day divided into 24 hours, the hour into 60 minutes and the minute into 60 seconds. Some of our military men have tried valiantly to free us of ante meridian and post meridian, but without too much success. Adoption of the metric system would not alleviate this.

We would have to use new unique numbers: gravitational acceleration is 980 cm per sec^2 as against 32.2 ft per sec^2; sea-level barometer is 760-mm instead of 29.92-in. Hg; latent heat of steam is 540 cal per kg rather than 970 Btu per lb; absolute zero is −273 C instead of −460 F; heat equivalent of a kwhr is 860 cal rather than 3413 Btu; the calorific value of a coal might be 7200 cal per kg, or 8400 kwhrt per metric ton, instead of 13,000 Btu per lb.

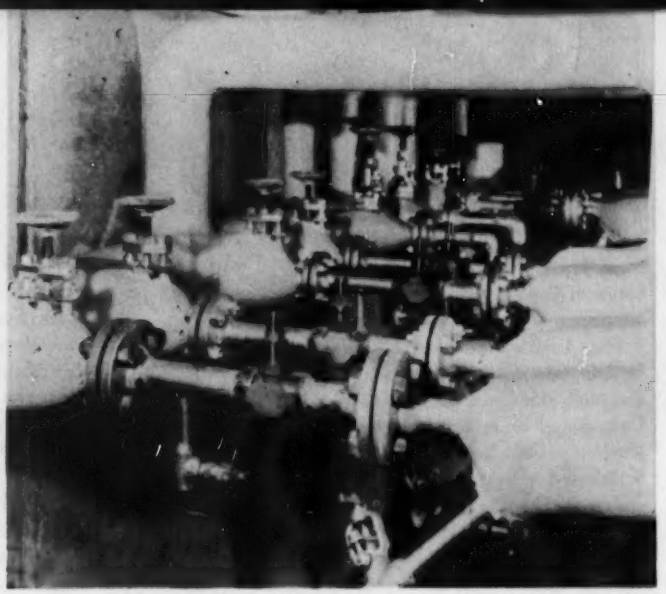
If we eliminate the British system and concentrate on the metric system, the memory burden of numbers will be cut about in half. But if we are to take the metric system to our bosom let's do so knowingly. It gives some practical advantage but is far from a panacea.

A better job could be done by starting on the counting tables and offering an entirely new system of weights and measures compatible with transposing the decimal point by multiplying by eight or twelve instead of ten.

Adopting the duodecimal system would bring many beneficial results. It would introduce some new complications that would have to be resolved. But it would bring many fundamental and lasting advantages. The more cumbersome counting tables impose additional mental loads—future generations might not appreciate the imposition. Future portent, however, seems to be for a decrease in manipulation of arithmetic and mathematics. The age of the computer is on us and should relieve us of many chores that plague schoolboy, scientist and the practicing energy-systems engineer.

By E W WALES, Application Engineer
Yarnall-Waring Company

Save real $ with flash steam



IMPULSE STEAM TRAPS drain extraction-steam lines in a large central power station. They keep low points in line free of condensate under all conditions

Stop wasting flash steam! Learn how flash-recovery systems can save heat for use in your lower-pressure steam equipment

Flash steam is found in almost every power plant, industrial process and heating system, and it can be an important source of heat energy for operating steam equipment. But to properly use flash steam we must understand its characteristics and learn how to control it.

One lb of water in a closed tank at 100 psig and 338 F contains 309 Btu of heat, according to the Steam Tables. If pressure is dropped to zero psig by opening a vent, this one lb of water can hold only 180 Btu. Hence there are 129 excess Btu (309 – 180 = 129), and this extra heat vaporizes some of the water. The vapor formed is called flash steam because it vaporizes so rapidly.

Steam Tables also show that at 0 psig 970.3 Btu of heat are needed to evaporate one lb of water. The excess 129 Btu, therefore, will vaporize 0.133 lb of the water (129/970.1 = 0.133). The 0.133 lb of water occupied 3.83 cu in., but after it flashes it fills 6150 cu in., 1600 times its original volume. Therefore where large quantities of hot water are subjected to high pressure drops, allowance should be made for flash steam formed in system so it can be controlled properly.

A common source of flash steam is return lines from steam traps used to drain condensate from industrial steam-heated equipment and related steam piping. In conventional condensate-return systems, condensate discharged by a steam trap flows through a discharge line to a return line and then to a receiver tank. In larger installations several return lines may be needed to gather the condensate from many trap-discharge lines. Here the return lines run to a common return main. Pressure in the receiver tanks is held close to atmospheric by venting and collected condensate is pumped back to the boiler.

When high-pressure condensate is discharged by steam traps, it passes immediately to the lower pressure of the return system. Some of the condensate starts to flash right at trap outlet. Since flash steam has a much greater specific volume than an equivalent weight of condensate, it literally chokes the trap-discharge pipe and a higher pressure is created at trap outlet than exists in return line and receiver tank. As pressure decays through the system, flashing continues along the piping — sometimes over full length of the return line. This is more likely to happen when a large number of traps discharge condensate close to steam temperature.

Pressure drop in piping systems and consequent extent of flashing is governed by size and length of the return line. If line has sufficient carrying capacity for the flow of flash steam and condensate at low friction losses, pressure in the return lines will be close to receiver-tank pressure. Here, practically all flashing takes place close to the trap. With undersized return lines, however, frictional losses are high. A high pressure drop through the return system means that large quantities of condensate close to steam temperature may continue flashing in the return line right up to receiver-tank inlet.

Heat losses from bare condensate-return piping also affect amount of flash reaching receiver. Outdoors, heat losses can be so high, especially in winter, that flash is quickly recondensed. On the other hand, high ambient temperatures and very hot condensate cause a high percentage of flash steam formed in return piping to discharge into receiver tank.

So that flash steam will separate from condensate when entering re-

Percent of flash steam formed

Initial steam press., psig	Sat temp, F	Flash-tank pressure, psig												
		0	5	10	20	30	40	50	75	100	125	150	175	200
25	267	5.7	4.1	3.0	1.0	0	0	0	0	0	0	0	0	0
50	298	9.0	7.4	6.2	4.3	2.6	1.0	0	0	0	0	0	0	0
75	320	11.3	10.8	8.6	6.7	5.0	3.7	2.5	0	0	0	0	0	0
100	338	13.3	11.7	10.6	8.7	7.0	5.7	4.6	2.2	0	0	0	0	0
125	353	14.8	13.4	12.2	10.3	8.7	7.4	6.3	3.8	1.7	0	0	0	0
150	366	16.8	14.8	13.7	11.8	10.2	8.8	7.8	5.4	2.3	1.6	0	0	0
175	377	17.4	16.0	15.0	13.0	11.6	10.0	9.0	6.7	4.6	3.0	1.5	0	0
200	388	18.7	17.5	16.2	14.4	12.8	11.5	10.4	8.0	6.0	4.4	2.8	1.4	0
225	397	19.7	18.2	17.0	15.4	13.8	12.4	11.4	9.0	7.0	5.4	3.8	2.5	1.0
250	406	20.7	19.2	18.2	16.4	15.0	13.6	12.5	10.0	8.2	6.6	5.0	3.6	2.3
300	422	22.4	21.0	20.0	18.2	16.7	15.5	14.4	11.0	10.0	8.5	7.0	5.7	4.3
350	436	24.0	22.7	21.6	20.0	18.4	17.0	16.0	13.8	12.0	10.4	8.9	7.5	6.2
400	448	25.5	24.2	23.0	21.5	20.0	18.7	17.7	15.6	13.5	12.0	10.5	9.2	7.9
450	459	26.8	25.3	24.4	22.7	21.2	20.0	19.0	16.8	15.0	13.4	12.0	10.6	9.3
500	470	28.2	26.7	25.7	24.0	22.6	21.4	20.4	18.2	16.4	14.6	13.4	12.2	11.0
550	480	29.2	27.8	27.0	25.3	23.7	22.6	21.6	19.5	17.5	16.0	14.7	13.4	12.2
600	488	30.2	28.8	28.0	26.4	25.0	23.6	22.7	20.5	18.7	17.3	16.0	14.6	13.4
Total heat of flash steam, Btu per lb		1150	1156	1160	1167	1172	1176	1179	1185	1189	1193	1195	1197	1199
Latent heat of evaporation, Btu per lb		970	960	952	939	929	919	912	895	881	868	857	847	837
Heat of liquid, Btu per lb		180	196	208	227	243	257	267	290	309	324	338	350	362
Saturated-water temperature, F		212	228	240	259	274	287	298	320	338	353	366	377	388
Volume of flash steam, cu ft per lb		26.8	20.0	16.3	11.9	9.4	7.8	6.6	4.9	3.9	3.2	2.7	2.4	2.1

Calculate flash steam and heat content

In an industrial plant, 40 steam traps of various sizes discharge a total of 85,000 lb per hr from equipment operated at 125 psig. Condensate flows to a vented receiver operating at five psig. How much flash steam is formed if condensate discharge is very close to steam temperature? How much heat is available in the flash steam?

Enter table at 125 psig and cross to the right, 5-psig final pressure. Flash steam formed is 13.4%. Total quantity of flash steam formed is 11,400 lb per hr (0.134 x 85,000 = 11,400 lb per hr). Latent heat of evaporation of this flash steam is 960 Btu per lb. So heat available at five psig is 11-million Btu per hr (960 x 11,400 = 11,000,000 Btu per hr) if all flash steam can be recovered.

This heat energy could be used to heat water from 40 to 180 F (rise of 140 F). If water heater has an overall efficiency of 85%, quantity of water heated would be 67,000 lb per hr (11,000,000 x 0.85 / 1 x 140 = 67,000 lb per hr) or 8000 gph. And condensate from the water heater can still be returned to an atmospheric receiver for reuse in the boiler.

ceiver tank, return line should enter the top section of the tank. As condensate falls in the tank, flash steam rises to top, is wasted to atmosphere. In many cases this flash steam could be piped to low-pressure steam equipment instead.

In most process and space-heating equipment, condensate must be removed quickly for maximum heat-transfer rates. Condensate leaves fairly close to steam temperature and when discharged by traps produces a maximum amount of flash steam. Under these conditions, quantity of flash steam formed in return lines can be estimated using table above. Table shows percent of condensate which flashes as a result of pressure drop between trap inlet and receiver tank. It also lists a few useful characteristics of flash steam and condensate at the final pressure. Remember, this table assumes that condensate discharges from traps close to steam temperature for trap-inlet pressure. Sometimes condensate subcools considerably in equipment; then percent of flash steam formed is obtained from the table by using actual temperature of condensate at trap inlet and receiver pressure.

Flash-steam recovery often involves a closed flash tank operating at a pressure above atmospheric. Mixture of steam and condensate in the return line enters tank through a top inlet or centrifugally through a side inlet near the top. As condensate cascades to bottom of tank it separates from flash steam, and where flash-tank pressure is lower than condensate-return main, more condensate will flash as it enters the tank. Flash steam can be piped from top of tank to steam equipment; remaining condensate collecting in bottom of tank is pumped to the boiler or a receiver tank for reuse in the system.

An arbitrary method of determining flash-tank size states that the allowable weight in lb of flash steam which can be produced per hr per sq ft of water surface is equal to three times the absolute pressure in the tank. But this gives you an oversized tank because it doesn't account for the large additional steaming surfaces of the condensate as it flows through return-system piping and

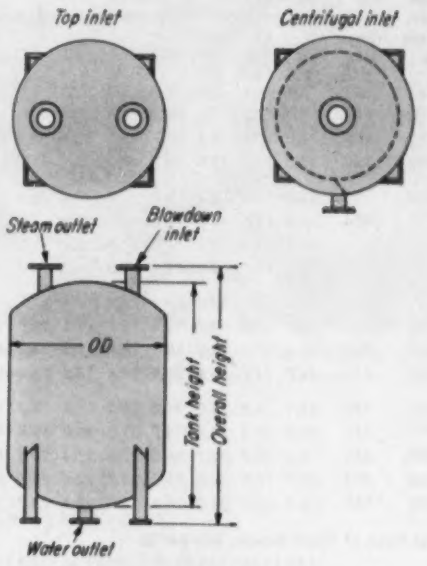
Standard flash tanks available

Maximum ratings, 1000 lb per hr of flash steam

Tank no.	Flash-tank pressure, psig											
	1	2	5	10	20	30	40	50	75	100	150	200
	Centrifugal flash tanks											
2	1.5	1.6	1.8	2.3	3.0	3.9	4.8	5.5	7.5	9.5	13.0	17.0
3	3.2	3.4	3.9	4.9	6.4	8.5	10.0	12.0	16.3	20.0	27.7	35.0
4	6.0	6.1	7.1	8.8	12.0	15.0	18.0	21.0	27.0	34.0	50.0	66.0
5	16.0	17.0	20.0	24.0	32.0	41.0	49.0	58.0	79.0	100.0	142.0	184.0
6	27.0	29.0	34.0	42.0	58.0	73.0	89.0	105.0	142.0	180.0	254.0	329.0
	Top-inlet flash tanks											
2	1.1	1.1	1.3	1.7	2.2	2.8	3.4	4.0	5.5	6.9	10.0	13.0
3	2.2	2.5	2.9	3.5	4.9	6.1	7.4	8.7	11.8	14.8	21.4	25.4
4	4.3	4.6	5.2	6.5	8.7	10.8	12.9	15.0	20.0	25.0	36.0	46.0

Dimensions of commercial flash tanks

Tank no.	Outside dia, in.	Tank ht, in.	Over-all ht, in.	Inlet-pipe size, in.	Outlet-pipe size, in. Steam	Water
	Centrifugal flash tanks					
2	24	56	66	2	3	1½
3	36	62	72	3	4	2
4	48	67	77	4	6	4
5	60	78	88	6	8	6
6	72	89	99	8	10	6
	Top-inlet flash tanks					
2	24	56	65½	3	3	1½
3	36	62	71½	4	4	2
4	48	67	76½	6	6	4



STANDARD FLASH-TANK dimensions are shown for both centrifugal-inlet and top-inlet designs

How to size a flash tank

In example on previous page, we determined that 11,400-lb-per-hr flash steam was available at five psig for use in other equipment. What size and type flash tank should be selected and what are its dimensions?

In table at top left, start at five psig and go down until flash-steam flow is covered by tank rating. For 11,400 lb per hr, a No.-5 tank rated 20,000-lb-per-hr maximum is needed. Tank must be centrifugal-inlet type since no standard top-inlet tank is shown for 11,400 lb per hr.

From table at lower left, No.-5 tank with centrifugal inlet will have 60-in. dia, 88-in. overall height, 78-in. tank height, with 6-in. blowdown inlet, 8-in. steam outlet and 6-in. condensate outlet at bottom.

Courtesy of The Cochrane Corporation

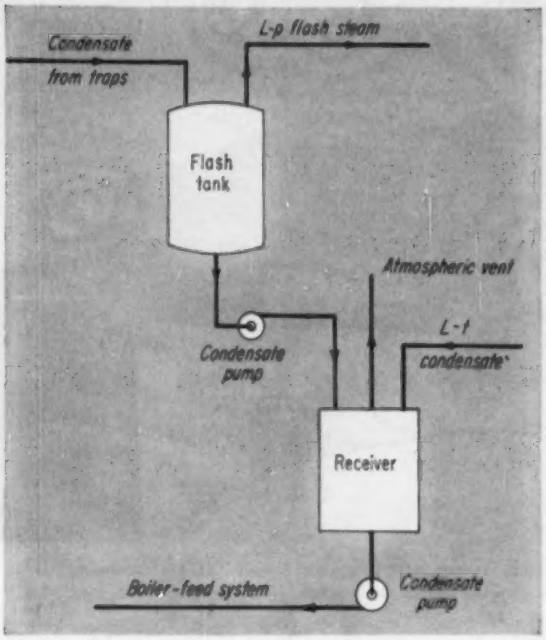
down into tank. Since it's practically impossible to figure total steaming surface for the entire condensate-return system, flash-tank design is usually based on experience.

Experience is the basis for design parameters shown above. Tables give maximum ratings for various sizes and types of commercial flash tanks in terms of 1000 lb of flash steam per hr. Note separate ratings for tanks with centrifugal inlets and with top inlets. Top-inlet ratings are approximately 70% of those for centrifugal inlets. In the later case, condensate spirals to the bottom instead of falling directly; longer path provides more time and surface for separating flash steam from condensate. Dimensions of both types of standard tanks are shown above.

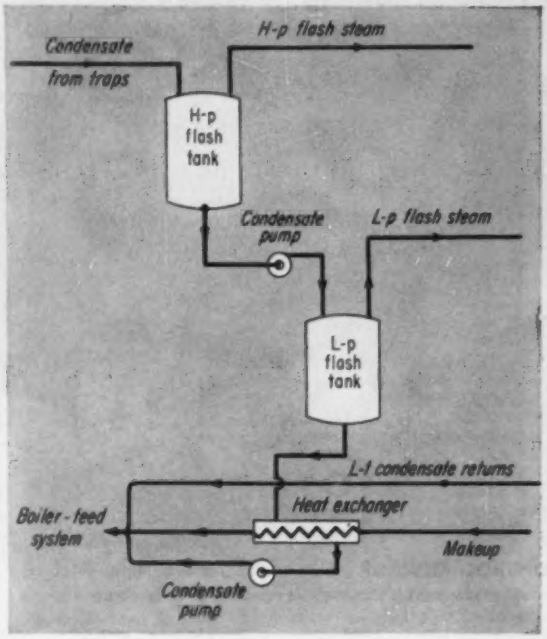
When designing a flash tank, remember that velocity of steam must decrease as tank operating pressure increases. This prevents carryover of condensate into low-pressure steam line. Tank ratings have been developed to minimize possible carryover. Size of steam outlet has an appreciable effect on exit velocity and therefore carryover—don't skimp here.

Tables above can also be used to select a vented receiver for a normal condensate-return system. In the example, the same type and size tank could be used except that steam outlet would vent to atmosphere. Tank pressure would be less than five psig because flash steam freely flows out the vent and amount of flash is considerably below maximum tank rating. For overloaded receiver tanks where pressure (and therefore condensate temperature) is too high to feed to boiler-return pump, increase

Single- and multistage flash-recovery systems save maximum heat



SINGLE-STAGE FLASH SYSTEM recovers heat at low steam pressures. Drains mix with condensate, flow to boiler-feed system



MULTISTAGE FLASH SYSTEM recovers heat at high steam pressures. Note that low-pressure flash steam is also available here

size of steam outlet and vent pipe as a temporary way to lower pressure.

When designing return piping, remember that your pipe must carry a mixture of flash steam and hot condensate. So its size will be somewhere between that correct for pure steam and that proper for water. If return line is too small, abnormally high pressures will build up at trap outlets, decreasing discharge capacity and preventing proper operation. Observe trap manufacturer's recommendations on size of return piping.

Where steam-heated equipment operates at pressures above 200 psig, it may be desirable to use two or more flash tanks in series. Mixture of condensate and steam enters high-pressure flash tank and some condensate flashes. Flash steam can be recovered for use in appropriate-pressure steam equipment. Remaining condensate in high-pressure flash tank is drained or pumped to a lower-pressure flash tank where more condensate flashes to be recovered at this pressure level. Remaining condensate returns to boiler.

Because multistage-flash-tank systems are expensive they deserve very careful consideration. Most important requirement: make certain a continuous and adequate supply of condensate is available at a high enough temperature and pressure to produce required flow of flash steam at the lower operating pressure.

You can save money by using flash steam if you plan and design your system properly. Here are some tips to keep in mind:

(1) Study all steam equipment in your plant and see which gives a continuous supply of high-temperature condensate which could be used.

(2) Find out which items can be operated on low-pressure flash steam. Remember some of these may presently operate on boiler steam through a reducing station. Most important thing is to determine *actual* steam pressures and temperatures required to operate each piece of equipment. Don't be fooled by present operating conditions—they may be much higher than necessary.

(3) Check economics of using flash steam in each case. Cost of flash tank, piping and fittings plus installation must be balanced against savings. But remember that while cost of equipment is a one-shot proposition, operating savings go on—year in and year out.

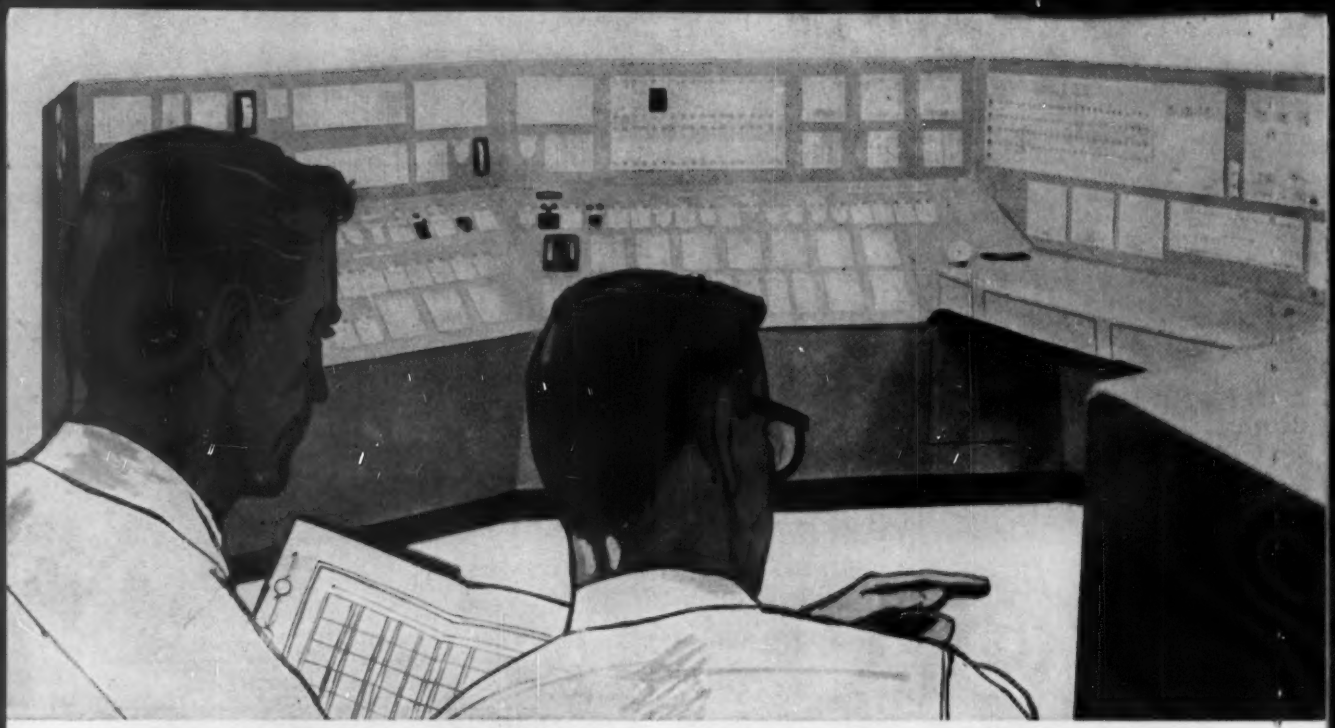
(4) Be sure that piping for low-pressure flash steam is adequately sized to minimize pressure drop between flash tank and steam equipment. Insulate piping and flash tank to cut heat losses and save money.

(5) Consider insulating condensate-return lines to reduce heat losses so maximum flash steam is recovered.

(6) Consult flash-tank manufacturers to be sure tanks are in accord with ASME Unfired Pressure Vessel Code. Check local code and insuring-company requirements.

(7) Check type of steam traps used. Some types discharge condensate close to steam temperature while others require considerable subcooling before they open and discharge. Where you contemplate recovering flash steam, former gives maximum steam, lets steam equipment operate at top efficiency (see POWER, Jan 1959, pp 162-165).

Utilization of flash steam can save heat, cut fuel costs and improve plant efficiency. But it takes proper planning to assure good results.



CONTROL MOCKUP of operating console takes shape as system engineers plan placement of computer functions and all subloop instruments. Computer console appears in center; each wing panel contains controls and indicators for one unit

Southern California Edison plans for

Here's a look at current thinking for two automated once-through units now going in at expanded Huntington Beach Steam Station

Fully automatic steam power plants have been dreamed of, discussed, planned—and finally are about to go into operation. Southern California Edison Company was the second utility to announce plans for computer control. Because of accelerated design and construction schedules, they should have a computer-controlled plant running soon after Louisiana Power and Light's Little Gypsy goes on the line. (For Little Gypsy's story, see POWER, May 1959, pp 64-65.)

Aside from rapid progress to date, Southern California Edison engineers are to be applauded for the terrific job of planning that went into preparing Huntington Beach's two once-through steam cycle for computer control. To help you keep abreast of current thinking on the automatic plant, let's follow through highlights of the planning that went into control-system layout and application of the various control components.

System analysis demanded a lion's share of design effort. Main design problem for computer control reverts to the basic criteria for any control: knowledge of the cycle and a well-thought-out program of what control must do.

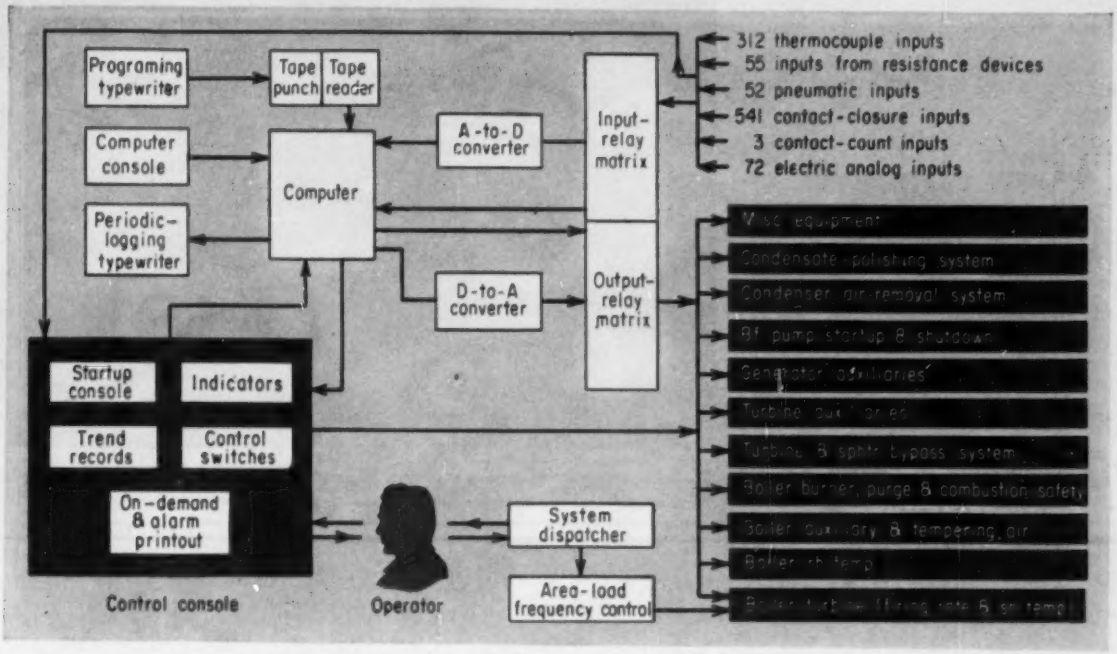
The once-through cycle used with these two units is still sufficiently new that step-by-step startup routines were prepared following recommendations of boiler and turbine-generator manufacturers. For details on control of once-through cycles see POWER's April '59 *TD, Control of supercritical units*, pp 63-68.

Major effort went into analysis of turbine-bypass control for startup, shutdown and low-load operation. In addition, these units will employ a condensate-polishing system which must be controlled automatically and integrated into the overall computer-monitored system.

Final scheme is designed to control automatically five basic plant operations: cold startup, hot restart, normal operation, normal and emergency shutdown. The computer will be in direct control of plant functions primarily during startup and normal shutdown.

Drum memory will be programed to supervise and execute step-by-step startup until the boiler-turbine-generator cycle operates at approximately one-third load. Normal shutdown will be logically programed to prepare for cold or hot restart. Emergency shutdown procedure, as with any other plant, must be governed by the specific problem involved and solutions available.

During startup, computer will control the boiler by initiating burner controls and limiting firing rates until boiler metals, gas and steam reach proper working temperatures. Computer also will control all miscellaneous boiler equipment during the startup sequence.



CONTROL FUNCTIONS contain parallel paths of operation by computer and human operator. Computer shares data from input instruments with operator. Prime use of computer stems from never-fail memory of operating sequence plus fast reaction

computer control

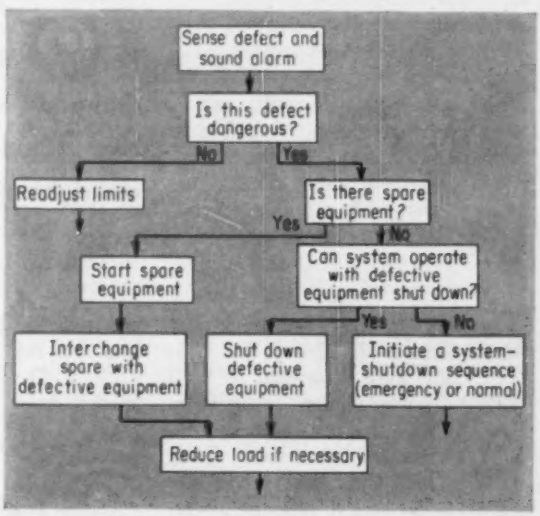
Turbine-generator control by computer takes similar form: supervisory instruments will be monitored, startup guided accordingly. Key valves in the boiler-turbine bypass and feedwater systems will be operated directly by the computer during startup, shutdown or upsets.

Computer control ends with completion of a satisfactory startup. Then computer functions as a plant monitor, scanning, recording, computing, monitoring and tripping alarm circuits.

Plant safety becomes partly the job of the supervisory computer system. System must be programed to prevent equipment from misoperating by overriding the normal control. Typical programed logic for computer decisions appears at right. Where engineers can foresee hazards and determine corrective action the computer is preprogramed, but where decisions of magnitude or multiple alternatives are concerned, computer does not supercede human operator, whose judgment and experience can't be programed.

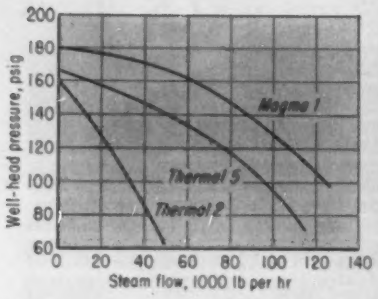
Computer responsibility is limited to specific operations. Nature of plant cycle and functions to be assigned to the various controls indicate that the computer is not considered the only significant item in overall control. While the merits of the computer were not overlooked, Southern California Edison engineers recognized that other controls, both conventional and specialized, were of equal importance. Block diagram, above, outlines computer's functions and indicates where and how it fits into integrated control system.

Future controls undoubtedly will take a modified form of these first systems, but the basic thinking on operating responsibility and significance of computers in the overall scheme of things probably will hold for some time to come. The computer now emerges, not as the be all and end all of control, but as a useful component within a whole system, ready to compensate for the human operator's frailties but not competing for the responsibility of considered decisions.



COMPUTER DECISIONS follow logical path required of human operator. Big advantage: speed in deciding and acting

Source of data was a technical paper, "Digital-computer control of the Huntington Beach Steam Station," by A L Guidero, submitted at the Instrument Society of America conference, May 8, 1960, San Francisco, Calif.



1 Steam pressure at well heads drops as the steam flow is allowed to increase

2 Tests were carried out at steam-well heads to find pressure-flow relation, enthalpy, noncondensable-gas entrainment, chemical content, corrosiveness and radioactivity

First U.S. geothermal power plant...

harnesses magmatic steam to generate energy for Pacific Gas and Electric Company at site 95 miles north of San Francisco. Study showed economic feasibility if enough steam could be made available to generate 12.5-mw capacity

The hot springs, fumaroles and steam vents in the area of The Geysers, Calif. were discovered in April 1847 by a bear hunter. In the years 1860 to 1880 this area became a famous sightseers' attraction. From 1921 to 1925 eight steam wells were drilled in the area to generate power. The project was dropped when it couldn't compete with power generated by oil-fired and hydro stations.

Development. In 1955 the Magma Power Company obtained an exclusive long-term lease on 3200 acres to harness the steam for generating electric power. They drilled one well in Oct 1955. In 1956 Magma agreed with the new Thermal Power Company to share the benefits and expenses if Thermal Power would drill additional wells, help sell the steam.

From July to September of 1957 Thermal Power Co drilled five wells and redrilled Magma 1. Thermal 4 blew out the nose of a hill during drilling. Thermal 3 did not develop enough steam so it was abandoned. Depth of later steam wells runs 523 to 1404 ft with steam production at 500 to 700 ft.

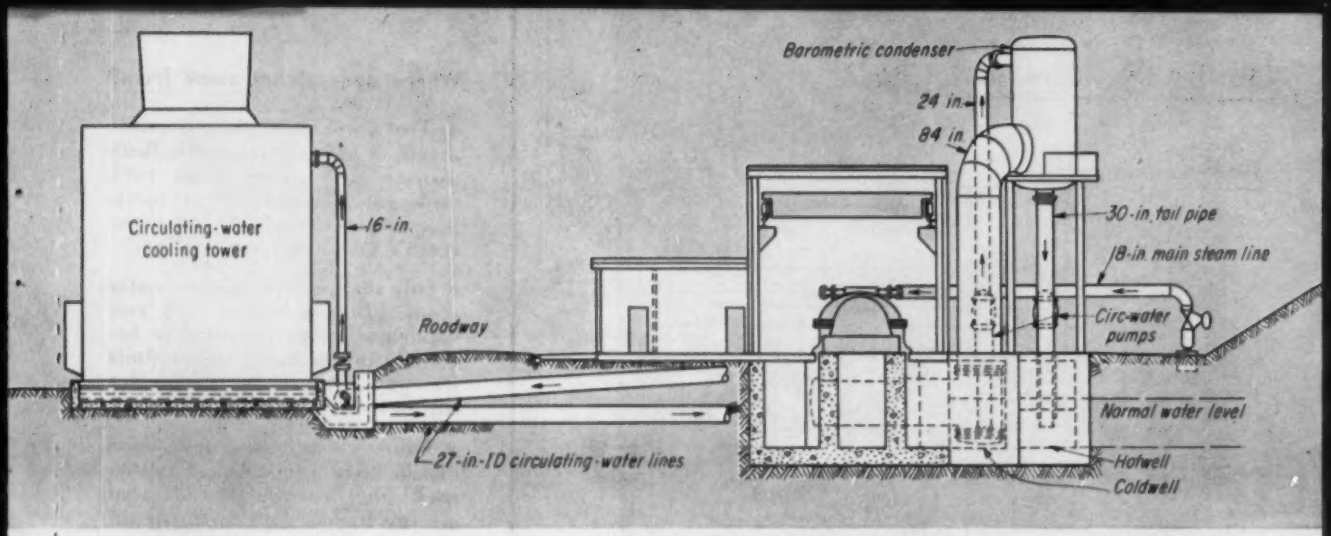
On the basis of flow tests made by Thermal Power, Pacific Gas and Electric Company made economic studies to find what it could afford to pay for the steam. On Oct 30, 1958 PG&E signed a contract with Thermal Power to build The Geysers Power Plant when Magma and Thermal companies developed the necessary steam supply.

This plant will be the first commercial geothermal plant in the U.S. and the world's first privately financed one. Interestingly, the Geysers Resort, a local hotel, has run a steam engine on geothermal steam for years driving a 15-kw 110-v dc generator.

Steam supply will probably last longer than needed to make the new plant economically successful. Wells drilled in the '20's are believed to be producing at the same rate today as when they were first opened. Fumaroles in the area have existed for over 100 years and hearsay claims constant activity during that time.

Plant design. Steam-well pressure drops with increasing flow, Fig. 1. Some combination of flow and pressure produces maximum power; the first unit will run at 100 psig, Fig. 3 and 4.

Turbine exhausts to a barometric condenser where injection water condenses the steam. Mixture collects in a hotwell to be pumped to an induced-draft cooling tower. Most of the condensate evaporates to atmosphere in the tower; the remainder collects as cool water in the tower



3 The Geysers Power Plant cooling tower, left, cools injection water for the barometric condenser, right. Condensate forms the injection water for condenser after cooling tower removes its heat. Excess condensate overflows to waste in nearby stream

basin. This acts as injection-water source for the condenser; there's an excess, so some of the cooled water has to be rejected to waste, Fig. 4.

Noncondensable gases in the steam make large gas-ejecting equipment necessary. Steam-jet ejectors proved less costly than mechanical gas pumps. For 240,000-lb-per-hr steam input to the plant, the first-stage jet uses 5300 lb per hr and the second-stage jet 4900 lb per hr. Steam to the plant first passes through a mechanical separator at each well to remove the entrained solid matter.

An economic study set the turbine backpressure at 4-in. Hga. A lower backpressure would need more cooling water and gas-ejector steam, larger circulating-water pumps and cooling tower. Studies may show future units to be most economical at 3-in. Hga.

Cooling towers will be standard induced-draft design with three cells, designed to cool 12,000 gpm from 120 to 80 F at a wet bulb of 65 F. Plastic fill and stainless-steel hardware will resist corrosive effects of the water. Cast-iron-column anchors will be Heresite-coated and the tower basins will be reinforced concrete coated with coal tar.

Towers will run with continuous blowdown of 12 to 40% of the condensed steam which supplies makeup. This will limit buildup of undesirable chemicals. Disposing of blowdown flow awaits actual operation: if contamination is high the flow may be retained for treatment before discharging to local streams.

Steam turbine for the plant was the former Unit 2 of PG&E's Sacramento Plant installed in 1924. This General Electric 9-stage 1800-rpm unit designed for 175-psig 478-F inlet and 1.5-in.-Hga exhaust has been rebuilt to run with 100-psig saturated steam.

Two butterfly valves, six and ten in., replace the control valves. First three stages were removed and the remaining six diaphragms were replaced because hydrogen sulfide in the steam may deteriorate the copper brazing. The eighth- and ninth-stage buckets were changed to raise the flow; they'll be made of 11-13% chrome steel. Diaphragms will also be enlarged. Monel buckets in the fourth to seventh stages were retained —no mercury vapor has been found in the steam, though mercury is mined a few miles from the plant.

An emergency stop valve of the swing-check type backs up the turbine throttle valve. Fine mineral matter in the steam may make the stem of the throttle valve stick.

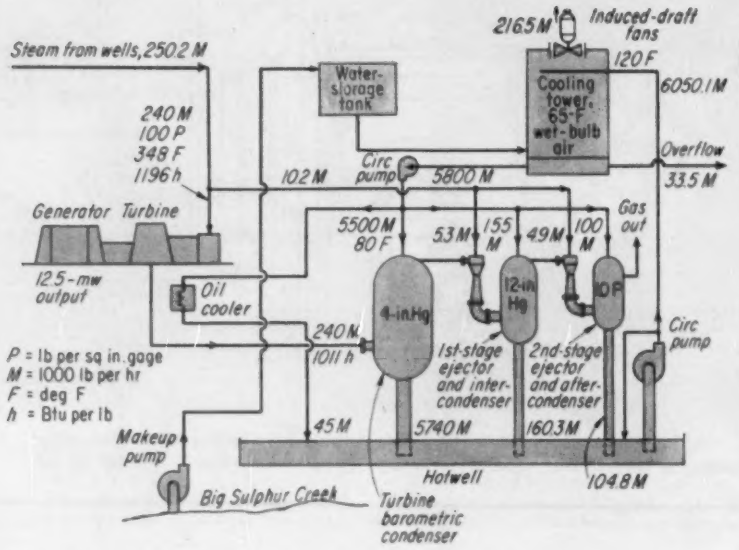
Barometric condenser to hold 4-in.-Hga backpressure on the turbine doubles the power generated over that for an atmospheric-exhaust unit. This type condenser proves cheaper than a surface condenser for degassing the condensate.

The 120-in.-dia condenser vessel, about 23-ft long, mounts vertically with an 84-in. steam inlet. Cooling-water inlet is 23-in. dia and the outlet is 30 in. The first-stage ejector mounts on the vessel with the gas connection at the vessel top.

The second-stage ejector mounts on the intercondenser. Mixture of gases and motive steam passes into the after-condenser. Cooling water and condensate of the after-condenser drains into the hotwell. Intercondenser runs at 12-in. Hga and the after-condenser at one psig. Condensers are carbon steel internally clad with Type-316 low-carbon stainless steel. Gas ejectors and condenser internals are made of solid 316 stainless steel.

Circulating-water pumps are of the vertical-turbine type. The full-size condenser-supply pump takes suction from the coldwell and has a capacity of 11,600 gpm at 29-ft head. Full-size cooling-tower-supply pump takes suction from the hotwell and has a capacity of 12,300 gpm at 50-ft head. All parts in contact with water will be type-316 stainless steel.

Turbine-oil cooler will have its admiralty tubes and bronze tube



4 Heat balance of The Geysers Power Plant shows most of entering steam to turbine leaves as humidity in air leaving cooling tower; about 13% leaves in form of water

Where does steam come from?

- **Two theories explain possible origin of geothermal steam. Both assume heat comes from rock undergoing magmatic or metamorphic processes deep in the earth's hot untapped interior.**
- **One theory says surface water seeps down to heated rock and vaporizes under pressure to become superheated. Steam finds its way to surface fumaroles through connecting rock fissures.**
- **Other theory assumes steam distills from magma (hot molten rock) that is solidifying or from granite hot enough to throw off its water of crystallization.**
- **Steam may come from both sources. In any event, it appears to be on tap for many centuries into the future.**

sheets replaced with aluminum. The latter will better withstand corrosion by the cooling water. Original filter and oil storage tanks are in good condition and will be used.

Service-water makeup pump passes water from the creek on the plant site to a 50,000-gal storage tank on the hill. The 100-gpm 300-ft-head pump will run automatically, controlled by float switches in tank.

Automatic operation. The plant will run automatically without attendance. Faulty operating conditions that endanger the unit will shut it down and send an alarm signal to the Fulton Substation, ten miles away. Abnormal conditions that do not endanger the unit send a different alarm signal to Fulton. An area trouble man can then investigate and correct the condition.

An operating condition serious enough to trip the unit needs investigation before restarting. Manual starting will be used for this reason and to avoid the expense of automatic starting equipment.

Automatic synchronization will be used to resynchronize the generator with the system after a line fault has cleared. When a line fault trips the oil circuit breaker connecting the 11.5/60-kv transformer to the line, the unit will automatically govern itself to carry the 500-kw auxiliary load. After the line fault clears, the unit will automatically reconnect to the line and be loaded to 12.5 mw.

Start of the unit is expected this summer. PG&E expects to invest about $2 million in this project, about $160 per kw. Operating costs are expected to be low.

Agreement between PG&E and Thermal and Magma companies provides for a second turbine, when and if additional steam becomes available. The second plant will not be started until the first unit enters service.

Steam data. When the steam-well heads are kept at 115 psig, calculated to produce 100 psig at turbine inlet, the following data is found:

Well		*Steam flow, lb per hr*	*Steam enthalpy, Btu per lb*
Magma	1	76,000	1207
Thermal	5	50,000	1194
Thermal	10	52,000	1205
Thermal	11	105,000	1207

Steam blasts from the test nozzles at high velocity and produces a terrific roar. Ear plugs must be worn by personnel for protection.

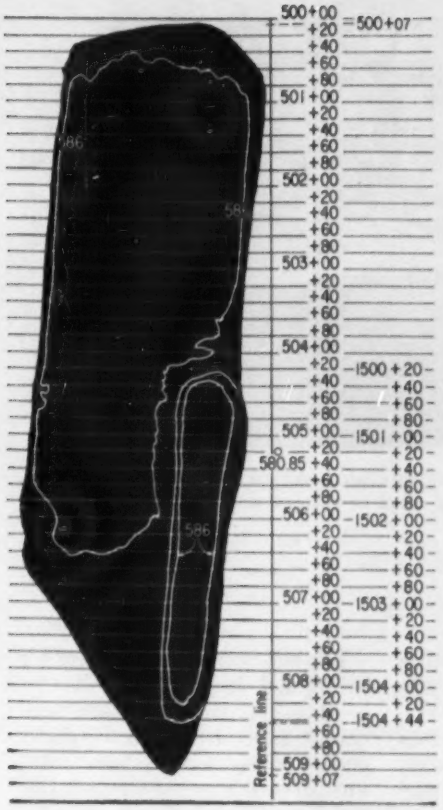
Entrained gas. Tests were made with the wells flowing full and also at small flows and shutdown. Considerably more gas was found in the steam during zero and small flow rates. Since the gases found in each well are about the same, steam from all the wells probably comes from a common source.

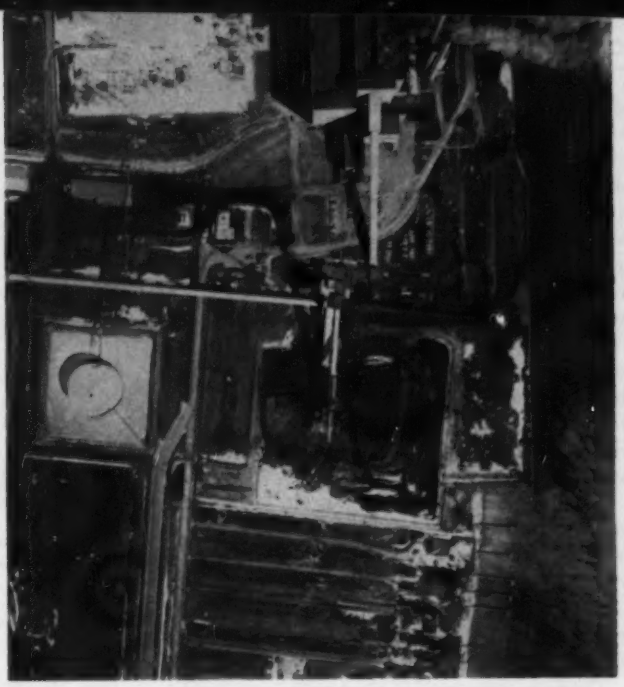
Noncondensable gases for the three wells vary from 0.68 to 0.83% by weight with a weighted average of about 0.75%. Analyses of the gases show these results when reduced to 60 F and 30-in. Hga:

Gas	*Volume, %*	*Weight, %*
CO_2	69.32	88.73
CH_4	11.81	5.49
H_2	12.70	0.74
N_2 & A	1.59	1.29
H_2S	2.99	2.96
NH_3	1.59	0.79
Total	100.00	100.00

Acknowledgments. POWER gratefully acknowledges the aid of Albert W Bruce, Supervising Mechanical Engineer of PG&E, Ben C Albritton, Senior Civil Engineer of PG&E, and Dan A McMillan Jr, President of Thermal Power Company, in supplying the basic data for this article.

Look for picture page in August.





1 Aerial photograph taken at 1500-ft altitude gives a scale of 1 in. = 250 ft in original. Coal piles being measured are just below center

2 Drawing of coal-pile outlines gives contour used as base to which volume measurements are made. Horizontal lines mark cross sections

New method speeds coal-pile measuring

Aerial mapping coupled with automatic data recorders offers improved way to inventory large coal stockpiles. It costs less, works faster and is more accurate

By LOYD V JEWELL, Surveying and Inspection Div, Detroit Edison Co and HOWARD JACOBY*, Jacoby & Associates, Inc, Hicksville, N. Y.

Last year the Detroit Edison Company inventoried its coal stockpiles using a method employing advanced aerial photogrammetric techniques. This method proves faster, more accurate and less costly.

Volumes of the coal piles were calculated by an electronic computer from vertical-cross-section data taken by aerial photography, Fig. 1. Automatic data-recording equipment attached to a conventional map-making machine (stereoplotter) speeds the process, Fig. 3.

Inventory method. Eleven stockpiles at eight sites along the Detroit and St. Clair Rivers, with a total area of 140 acres, were inventoried. Contract price for the measurement, including everything except ground control for the photography (furnished by Edison), came to $28 per acre. Cross sections were taken at 20-ft intervals, 10-ft for smaller piles.

Accuracy of the method probably runs within about 2%; this cannot be checked absolutely. Volumes were computed to a horizontal plane slightly above the actual base of the pile. Remainder was furnished by Edison from previous experience. Volumetric accuracy probably runs better than the accuracy of the density and moisture factors used to convert the volumes to weights.

Past practice. Edison had used conventional photogrammetric meth-

*Formerly with Photronix, Inc, Columbus, Ohio

ods to inventory coal piles for several years. These involve making a topographic map of each pile with 1- or 2-ft contours. They measured the area within each contour with a planimeter and figured volumes by the *horizontal slice* method, multiplying the average of adjacent areas by the vertical distance between.

Checks showed that the volumetric accuracy of the contour method runs about 3% for large even piles, with greater inaccuracy on the smaller piles and on piles with ragged contours.

Vertical cross section. Detroit Edison decided to engage Photronix, Inc to adapt their method of measuring highway-earthwork volumes for coal-pile inventory. Aerial photographs were made at a scale of 1 in. = 250 ft from flying height of 1500 ft. The flight crew notified plant operators of approximate time when the coal pile was pictured.

When the photos were printed, Photronix pin-pricked identifiable points on each 9×9-in. photograph and Edison survey crews made horizontal measurements and elevations of these points. These controlled subsequent orientation of the photographs in the stereoplotter. There were an average of five vertical control points and three horizontal control points for each coal pile measured. About 75% of the control came from existing data, used to control earlier aerial surveys.

Measurement. Overlapping 9×9-in. photos are oriented to a horizontal datum in the stereoplotter. Plotter gives the operator a 3-dimensional view of the coal pile for depth perception. Operator sets a "dot" on the ground to determine the elevation of this point.

Photogrammetric phase begins with the plotter operator's drawing pile outlines as carefully as possible at the horizontal plane down to which each pile's volume is to be measured. A line to which horizontal distances of cross-section points are referenced is then established, Fig. 2.

Maximum cross-section interval agreed upon was 20 ft. In ragged parts of the piles, however, sections were closer together to minimize possible error when averaging adjacent end areas in the volume calculations. Cross-section lines were stationed by code number, 1 + 00, 1 + 10, 1 + 20, etc. Each pile was stationed to differentiate it from the others. One pile was stationed in the 200+ range, another in the 300+ range, etc. Odd stations with zero end area were inserted at start and end of each pile.

3 Photogrammetric data recorder, left, hooked to stereoplotter, center, produces measuring record on punched tape and typewriter

Key to accuracy and economy of the vertical-cross-section method is the photogrammetric data recorder, developed by Photronix. It has a horizontal metal bar that guides the viewing frame (which holds the "dot"), an electromechanical device that keeps track of horizontal and vertical movement of the viewer and electronic circuitry to activate a punched paper tape and an electric typewriter.

In operation, the metal bar orients on a cross-section line. Station number of the section is then set by turning the proper knobs on an electronic console. Viewing frame is moved to the reference line which becomes zero horizontal (y) distance. Then it is moved out to a pile edge and the dot placed on the ground. Plotter operator steps on a treadle to punch out on paper tape and also type out the station number, (y) distance and elevation of the point. Operator then goes on to the next point, and so on across all the cross-section stations.

Details. As in all point-reading work of this type, cross-section points were taken at breaks in the pile surface. Over the entire job, involving some 12,000 points, average distance between readings was ten ft. In all, 620 cross sections were taken.

Some piles held two types of fuel —strip-mine coal for the modern h-p boilers and deep-mine coal for the older boilers. Edison indicated division of the coal piles on the photographs. Cross sections were taken with the same setting of the guide bar. Fig. 2 shows the planimetric sheet for one of these dual piles. Operator simply changed the station-number setting on the console as he started on the second pile. Table 1 shows an example of point printout.

The electronic-computer department of Photronix processed the tape through a tape-to-card converter. This automatically produces punch cards, the input for the IBM-650 electronic digital computer.

Checking. Before processing the cards through the computer, personnel checked the typed-out cross-section points for reasonableness and format, working with both the planimetric sheet and 9×9-in. photos. One simple check, for example, was seeing that first and last points on all pile sections were at or below datum elevation of the particular pile (the computer program figures exact intersection of the base plane). Another was measuring the distance between pile edges and the reference line on the planimetric map every fifth or tenth section.

After punch cards were corrected they were processed in the computer. Results were printed and delivered to Detroit Edison as shown in Table 2. Computer run required about one minute for every 1000 points.

1—Abstract of photogrammetric typewriter record

		Dist, 0.1 ft	Elev, 0.1ft	Dist, 0.1ft	Elev, 0.1 ft	Dist, 0.1 ft	Elev, 0.1 ft	Dist, 0.1ft	Elev, 0.1ft	Dist, 0.1 ft	Elev, 0.1 ft	Dist, 0.1 ft	Elev, 0.1 ft	Dist, 0.1 ft	Elev, 0.1 ft	
1350+40	L	3587	5910	3586	5928	3470	5914	3304	5912							9
1350+50	L	3563	5912	3562	5934	3309	5946	3105	5961	2712	5930	2372	5916	1986	5911	8
	L	0002	5911	596	5912	691	5914	1512	5914	1687	5936	1937	5939	2195	5941	8
	L	2326	5912	2817	5912	3120	5912	3310	5914							9
1350+60	L	3573	5910	3572	5935	3296	5947	2885	5984	2595	6006	2079	5954	1575	5944	8
	L	1021	5912	7	5911	750	5911	800	5919	821	5911	1562	5911	1810	5927	8
	L	1907	5933	2105	5942	2257	5919	2277	5911	2740	5911	2782	5937	2834	5977	8
	L	3056	5972	3256	5937	3382	5914	3400	5911							9
1350+70	L	3571	5911	3570	5941	3374	5949	3075	5969	2762	5992	2453	6021	2087	6053	8
	L	1835	6022	1430	5996	1055	5981	740	5960	325	5942	1	5935	299	5921	8
	L	0685	5912	944	5916	973	5911	1693	5911	1847	5916	1860	5919	1888	5908	8
	L	2005	5914	2037	5925	2049	5915	2111	5934	2136	5918	2211	5922	2257	5911	8
	L	2779	5911	2944	5931	3131	5935	3210	5912	3680	5911					9

Results. In addition to tabulation of end areas, volumes between sections and accumulated volumes, Edison was furnished a printout of all the cross-section points. This enabled them to spot-check accuracy of both the point readouts and the end-area computations. Test sections over two piles indicate a very good check between plotter elevations and level-and-rod elevations. These test sections were well within the specifications. Edison also received the planimetric sheet which located the sections and two prints of each aerial photograph.

Computer programs for the end area and volume calculations also can compute to a line connecting the first and last prints of a section and to a section representing the original ground, if client in question has such data available.

Edison studied the possibility of increasing cross-section interval to 40 ft, but found this did not give satisfactory results, particularly in irregular areas of the pile. Probably extra time taken to plot the standard 20-ft interval over all of a given pile is less than the time needed to decide whether a 40-ft interval would be adequate.

Accuracy. The contour method of measurement has two major sources of error: (1) those developed in drawing the contours and (2) those developed in planimetering the contours. Since spot elevations read directly from the photographs normally are accurate to within half the tolerance vouched for contour maps prepared from the same photographs, and since there is no planimetering, the vertical - cross - section method seems inherently more accurate. Average-end-area method of calculating volumes introduces some error, but probably errors due to spot reading plus averaging end areas about equals the accuracy of contouring. This leaves the vertical cross section ahead by the amount of planimetering error in the horizontal-area method.

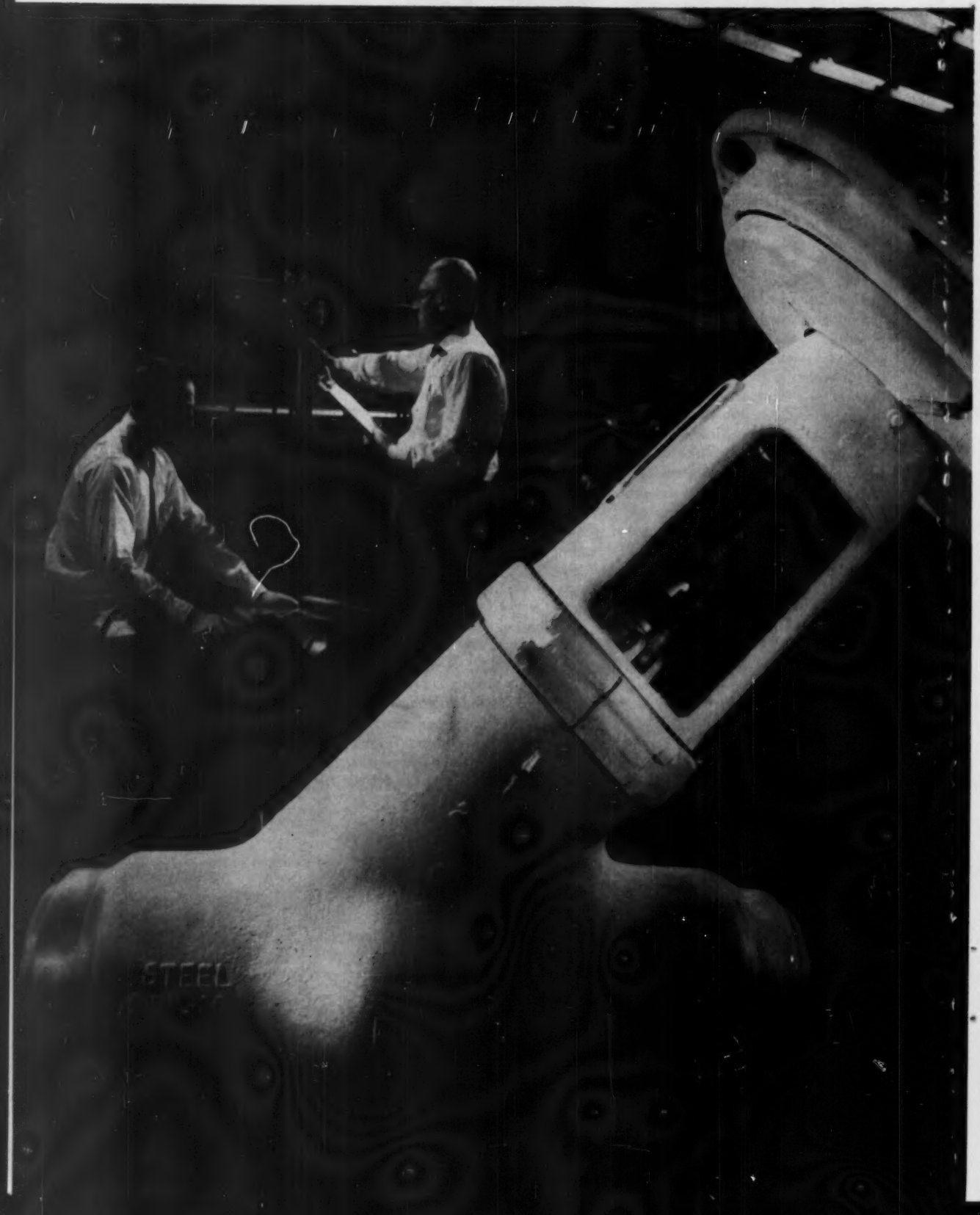
Absolute accuracy achieved by the vertical-cross-section method is hard to pin down. Because possible instrument error in reading points is independent of pile height, percent of absolute accuracy depends to some extent on the height of each pile. The average point reading error is probably ± 0.15 ft, while the mean error (balancing out pluses and minuses) is probably less than 0.1 ft. Volumes for all the piles are estimated at within 2% of actual, down to the datums measured to.

Economy of the vertical-cross-section method stems from eliminating the contour map and from the automatic processing of data. Both photogrammetric methods are superior to ground-surveying methods costwise, particularly because aerial photography yields an inventory as of the moment of exposure. Since stockpiles are always being worked and ground surveying may take weeks to perform, time of inventory is hard to establish with ground methods.

2—Final record of coal-pile measurement

Station	Area	Volume, cu yd	Accum volume
1350+40	17		
1350+50	641	121	121
1350+60	1666	427	548
1350+70	2887	843	1391
1350+80	4779	1419	2810
1351+00	6339	4116	6926
1351+20	6379	4710	11,636
1351+40	6538	4784	16,420
1351+60	6701	4902	21,322
1351+80	6786	4994	26,316
1352+00	7068	5130	31,446
1352+20	7326	5330	36,776
1352+40	7422	5462	42,238
1352+60	7054	5360	47,598
1352+80	6483	5012	52,610
1353+00	5956	4606	57,216
1353+20	5512	4246	61,462
1353+40	5108	3932	65,394
1353+60	4532	3570	68,964
1353+80	3551	2992	71,956
1354+00	1918	2024	73,980
1354+20	1426	1238	75,218
1354+40	2247	1360	76,578
1354+60	2024	1580	78,158
1354+80	1746	1396	79,554
1355+00	1456	1184	80,738
1355+20	1379	1050	81,788
1355+40	1443	1044	82,832
1355+60	1728	1174	84,006
1355+80	2270	1480	85,486
1356+00	1837	1520	87,006
1356+20	1668	1298	88,304
1356+40	1011	992	89,296
1356+50	356	253	89,549
1356+60	193	101	89,650
1356+70	81	50	89,700
1356+80	195	51	89,751
1356+90	42	43	89,794
1357+00	14	10	89,804
1357+10	5	3	89,807
			89,807

How Edward Valve Research



Reduced Pressure Drop 70%

Power industry advances in unit size created a need for large, high pressure steel valves (ten inch size and larger, 1500 lb class and higher) with three basic qualities: 1. Permanent tight seating; 2. Capacity to handle high flow rates being encountered in new, high pressure plants; 3. Reduced downtime through simplified maintenance. Edward researchers developed the Flite-Flow* design to satisfy that need. This is their story.

In 1951 Edward had already developed large cast steel globe valves with excellent dependability and repairability. Long experience in building inclined stem Y-type valves in small sizes indicated that this configuration offered a more efficient flow path. Edward research engineers set out to learn whether sufficiently strong pressure containing structures might be built in the Y-type design in larger sizes. They also sought to find out if pressure drop could be reduced sufficiently to make such a valve practical for high pressure power plant services.

The project consisted of three steps:

1. INTERNAL CONTOUR DESIGN—Flow tests were conducted with a series of plastic models. Early in the testing program it was observed that flow capacity was not always directly related to the size of the opening. Reduction of turbulence proved to be even more important. This eventually led to subtle internal contour changes to pre-shape the flow before passing through the valve seat. More material was added to certain internal areas to gain additional structural strength.

2. DISK GUIDING TESTS—To compensate for the angular position of the stem-disk assembly tests were conducted to determine whether conventional three-point guiding used in vertical stem Edward valves would be adequate for the inclined stem design. Experiments suggested that four equally spaced guiding surfaces would be superior. This is important in floating disk types such as check or stop-check valves where disk-piston assembly must seat automatically.

*T.M. Reg. U.S. Pat. Off.

3. STRUCTURAL STRENGTH—The usual weakness of a Y-type pressure containing vessel received much attention. Optimum valve contour as determined by flow testing permitted use of a structural member in the flow passage at the downstream side of the seat port. This structural member provides strength exactly where needed without significant increase in pressure drop. Introduction of this segment to the valve body casting without sacrifice in pressure drop was a significant achievement.

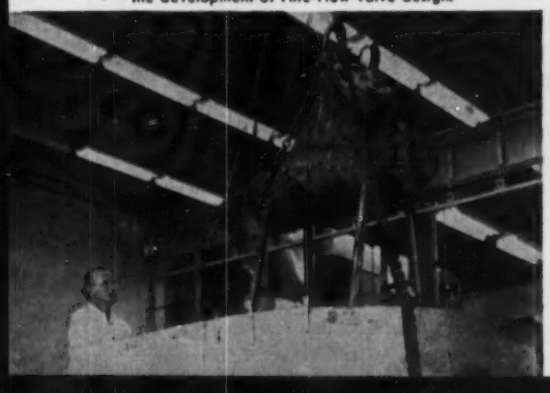
RESULTS: This program covered a period of six years. Tests of the completed design were most gratifying. Structural stability, a major problem, was excellent. Strain gage and brittle lacquer tests of finished valve bodies showed stresses well within acceptable limits. Pressure drop reduction amounted to as much as 70 per cent from best previous globe valve experience. Extended tests of finished product at pressures and temperatures above rating showed no operating weaknesses. The Flite-Flow is truly a dependable, repairable, low pressure drop valve.

Edward builds a complete line of forged and cast steel valves from ¼" to 24" for industrial, marine, petroleum and technological services. For more detailed information, contact your Edward Representative, or write Edward Valves, Inc., 1230 West 145th Street, East Chicago, Indiana. Subsidiary of Rockwell Manufacturing Company. Represented in Canada by Lytle Engineering Specialties, Ltd., 438 St. Peter Street, Montreal.

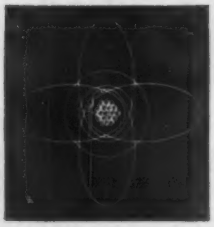
EDWARD STEEL VALVES
another fine product by
ROCKWELL

◀ **W. G. Lunt, research engineer, and E. B. Pool, chief research engineer, study flow phenomena in plastic half-model of tentative Flite-Flow design.**

▼ **Edward research team lowers experimental valve into test furnace where it is subjected to prolonged extremes of heat and pressure. This was one of the final steps in the development of Flite-Flow valve design.**



Cutaway view of Flite-Flow valve showing how inclined stem Y-type valve configuration has been adapted to larger size units for power plant services. This internal contour design enabled Edward research engineers to substantially reduce pressure drop.



Nuclear notes

By B G A SKROTZKI, Associate Editor

International Atomic Energy Agency says that highly radioactive wastes should not be discharged into the seas. On the other hand, sea disposal of low- and intermediate-activity wastes may be safe under controlled and specified conditions. Each disposal site should be designated by a national or international authority which should draw up rules for the site. Each site should be monitored to insure holding safe conditions and disposal records kept up to date. Waste disposal from nuclear ships should be logged on every ship for inspection by port officials. Disposal must conform to rules of local and international authorities. (*McGraw-Hill World News, Vienna*)

Civilian Power Reactor Program study by AEC has the first of eight volumes now available for sale: *Status Report on Boiling Water Reactor Technology as of 1959.* Designated as Book 5—TID-8518 (5)—it can be bought from Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., for 60 cents. Other books to go on the market before end of 1960 are: TID-8518 (1) *Data on Status of Gas Reactors;* TID-8518 (2) *Status of Pressurized Water Reactors;* TID-8518 (3) *Thermal Breeder Reactor Program—Aqueous Homogeneous Reactors;* TID-8518 (4) *Status of Heavy Water Moderated Reactors;* TID-8518 (6) *Status Report for Sodium Graphite Reactors;* TID-8518 (7) *Organic Reactor Program Status Report;* TID-8518 (8) *Gas-Cooled Reactor Concept.*

Private companies in Spain propose to build three atomic-power plants. *Nucleonor* plans a station with two 300-mwe units at Santa Maria La Garona, for operation in 1966. A third unit will be added later—all units to be powered by one common reactor. *Cenusas* plans two plants. One plant, 85 km from Madrid on the River Tagus, will have a rating of 250 mwe and start in 1968. The second 250-mwe-capacity plant, near Seville, will start in 1970. Reactor types have not been chosen. (*McGraw-Hill World News, Madrid*)

Research costs of AEC during 1960 are expected to run about $190 million; about $108 million will be for reactor development. Research will be done by both AEC and private organizations. About one-third of reactor development, biology and medical research will be done in university and industry laboratories.

Atomic-reactor progress continues to accelerate: In December 1957 the Army and Navy were running six reactors, today they run 28 and 47 more are being built. In December 1957 one large civilian reactor under the reactor-demonstration program was running, today two large ones are running with two more expected to go critical this year—five more abuilding.

Euratom and West Germany are joining forces for research and development on ship reactors. A study committee consisting of members from both organizations was scheduled to meet June 24 in Hamburg to set up the research program.

SNAP Experimental Reactor has run continuously for 1000 hr with coolant outlet temperature of 1200 F, producing more than 100 mwhrt. Rated capacity is three kwe; unit weighs about 220 lb without shielding and is the size of a 5-gal can. A small mercury-vapor turbine-generator has run for more than 2100 hr. The reactor was designed and built by Atomics International; turbine-generator was developed by Thompson Ramo Wooldridge.

◀ circle 241 on Reader Service card for preceding ad

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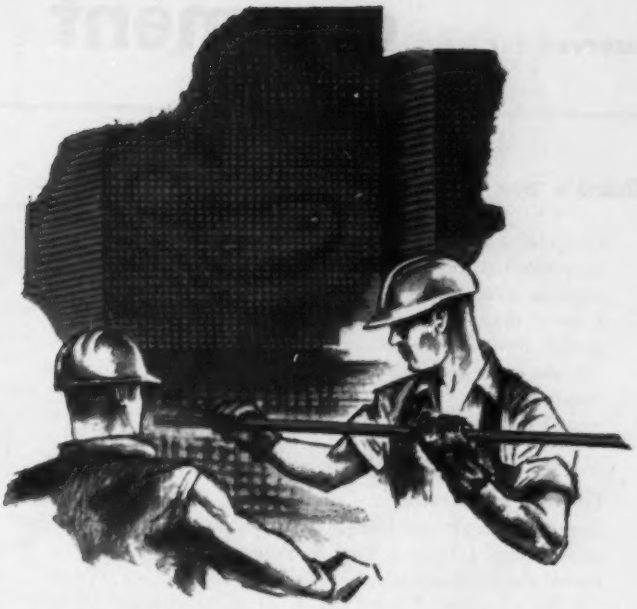

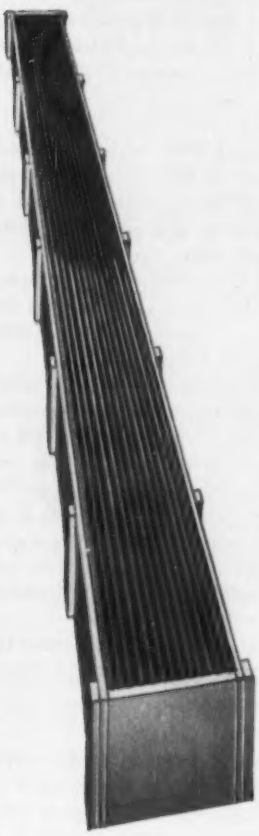

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For more facts circle 242 on Reader Service card, p 103

Reserved for your comment

BOB BELLAS, Associate Editor

Where's our leader?

Congratulations to George Edwards for his efforts in connection with standardization of operating-engineer licensing. I'm sure that POWER is doing a great deal of good by shepherding this much-needed project toward successful conclusion.

I am enclosing some information which may be useful in giving you a fairly complete picture of what has been done in the Province of Ontario.

F H LAWRENCE, *Kingston, Ont.*

EDITOR'S NOTE: *Reader Lawrence sent a copy of* Operating Engineers Handbook, *published by Ontario Dept of Labour, 8 York St, Toronto. He underscored the following which we feel is worth quoting:*

"The purpose of certification of the operating engineer in the beginning was on a basis of safety, and the value of tested engineers has been proven time and again over the ensuing years, in the fact that fatal and destructive accidents are the exception rather than the rule. To the safety angle may be added that of economy of operation and maintenance of the equipment, which is accepted by industry on the basis of the graded certificate holder.

"Thus we have the operating engineer contributing to the industrial wealth of this Province, by reason of safety, economy and maintenance. It is said that an engineer is a man who directs the forces of nature in the service of mankind, and this is certainly true when applied to the operating engineer. The employer may have expert knowledge in matters of manufacturing and salesmanship, but he often has to depend entirely upon the advice of the engineer in regard to power-plant operation. It naturally follows that he should wish to engage the best men available, and since he is not sufficiently familiar with the qualifications needed by an engineer, he is guided by the grade of certificate held by a prospective employee for the power plant.

"The employer understands that an engineer with a certificate has been put through a rigid test by the Board of Examiners. These men are familiar with engineering details and the higher the grade of certificate granted, the greater is the degree of knowledge required to be shown. . . .

"The engineer has gained prestige and standing from being a certified engineer. He must realize the dangers adherent to the operation of his power plant whereby skilled attention under normal and emergency conditions can save lives and prevent property damage. This statement can be made with as much truth today as at any time in the past, due to the possibilities of gas and furnace explosions, the accelerated evaporation in the modern boilers and *the misconception of the infallibility of automatic and packaged power equipment.*

"The Dept of Labour through the Board of Examiners has played a vital part in lifting the stationary engineer to a higher level of efficiency and as a guardian of safety. This contribution has given to the public greater security in the protection of homes, lives and property, and a more highly skilled tradesman to the employer."

So states the Province of Ontario about operating engineers within its jurisdiction. This feeling is shared by other political areas in Canada and some in the U.S. Using the best of local examinations and licensing procedures, it appears a relatively easy matter to come up with a standardized examination for all areas as proposed by George Edwards and many others.

. . . I'm glad to see that so many have commented favorably on the license-standardization proposal. It's agreed among all thinking engineers that a standard license would add to safety and every other aspect of power-plant operation.

To attain this, it will be necessary for operating engineers and their various organizations to get behind the proposal and use every means to get it into effect. If we won't work at it, who will?

We have many factors in our favor: power-plant management who are acutely conscious of operating costs, equipment manufacturers who are proud of their products and want to see best possible operating conditions and competent and responsible erection and installation people who have everything in apple-pie order at startup. All we need is a system that will guarantee that a licensed engineer has proved his know-how regardless of the geographic location of his license issue.

C G HOWARTER, *Canton, Ill.*

When Dresden was restin'

As POWER well knows and has publicized, Commonwealth Edison Company's Dresden Nuclear Power Station located near Chicago went on-stream recently and is attracting considerable interest because it is the first full-scale privately financed atomic-power plant to go into operation in the U. S.

Your readers may be interested in some "behind the scenes" activity involving a somewhat unusual boiler "installation" preparatory to putting the nuclear-reactor system on the line.

The project was a matter of checking the multi-million-dollar plant's steam lines and balancing the turbine. Problem was to set up a quick, easy, safe and economical method to provide steam capacity equal to output of the mammoth reactor system for testing without actually starting up.

The solution was use of two flatcar-mounted packaged steam generators positioned near the re-

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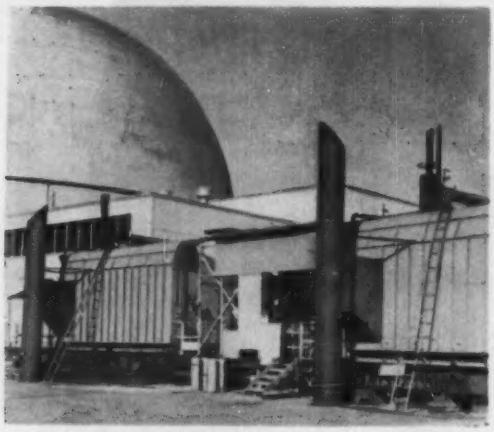
For more facts circle 243 on Reader Service card, p 103

actor's spherical-shaped containment vessel, photo below. Object was to set up the boilers so as to simulate the eventual pattern of nuclear operation.

Packaged steam generators used were two 55,000-lb-per-hr capacity Keeler DK units which were fired



up five days after their arrival at the plant site—without removing them from the railroad flatcars which had brought them from the manufacturer's plant. Fuel oil was led directly to the burners through temporary underground lines from nearby tank cars. The steam generators were operated at capacities up to 68,000 lb per hr for considerable periods during preliminary checking and later final testing of the plant's steam system and balancing of the turbine. Installed during the summer of 1959, boilers were removed when job was finished in Jan '60.

C E WILLIAMS, *Williamsport, Pa.*

Power to grow

It perhaps is not entirely by accident that George Edwards followed his story in May (*Is your child getting A's—and no education?*, p 206) with the equally interesting one in June (*Remember that as the twig is bent. . . ,* p 230), though I may be reading into them a connection he didn't intend.

First of all, a hearty pat on the back to Mr Noltie and his associates at Alpha-Molykote Corp for what they're doing with and for these kids. Certainly any parent would be delighted to see a movement such as this become countrywide in industry. Aside from the tremendous educational advantages to the children, the amount of good will engendered by such companies could be rewarding.

In connecting the two stories, it occurred to me that George Edwards suggests that possibly when *young* children were given such an intelligent approach to acquiring an education, they'd enter high school with an attitude that wouldn't permit the sort of thing he discusses in his May story.

Incidentally, I believe that Westinghouse Electric Corp is doing something at its Research Lab in Pittsburgh similar to Mr Noltie's activity.

R P CALDWELL, *Pittsburgh, Pa.*

EDITOR'S NOTE: *For a rundown on what Westinghouse Electric Corp is doing in this vein, see "Saturday's children,"* Business Week, *May 21, 1960.*

How about Texas numbers?

I enjoyed seeing the item "New number names" in your March issue (*Powerscope*, p 174-5). It is rather comforting to learn about this adoption, by your National Bureau of Standards, of the recommendations issued by the International Committee on Weights and Measures. Further, it might be pertinent to know from whence their initial suggestions came. I believe that Prof Otero de Navascués, chairman of the Spanish Nuclear Power Board and a member of the ICWM, had something to do with a similar subject some months ago.

Obviously, if the agreement leads the way to a simplification of the present dual system (American and European) in the computation of high figures, the news certainly sounds good but, I dare say, not quite sufficient.

In fact, what about 10^{15}, 10^{18}, 10^{21}, etc? Any resolution which might improve the universal understanding and the definite unification in their denomination would really deserve a world-wide appreciation. This would be particularly true in nuclear and astronautical fields where these high figures are constantly being dealt with.

J BARRIE, *Madrid, Spain*

Join our lonely-hearts club

We read *Industry's battle with fuel ash* with interest (*TD* report, April 1960, p 83-8). We have been using dolomite addition to two 400,000-lb-per-hr boilers for the last few years with satisfactory results. But we have trouble with the hopper and injector-feed units, which we made ourselves, because of the clogging characteristics of the dolomite powder and dust raised by dolomite-powder dispersal.

We are therefore much interested in a proved injection system and we should greatly appreciate it if you would inform us where we can get details on the dry-addition dolomite-feed units, shown in the photo on page 87 of your April issue.

C ROSENBERGER, *Technical Div*
The Palestine Electric Corp, Ltd
Haifa, Israel

EDITOR'S NOTE: *We're happy to be able to put Reader Rosenberger and the manufacturer of this equipment in touch with each other.*

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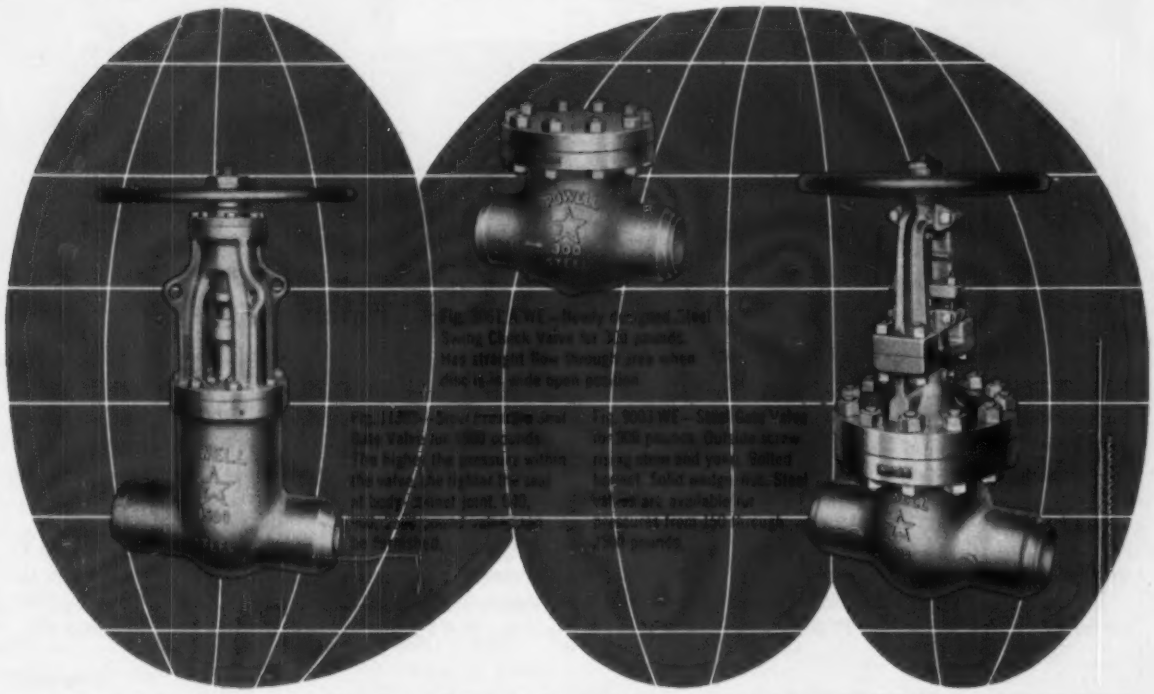

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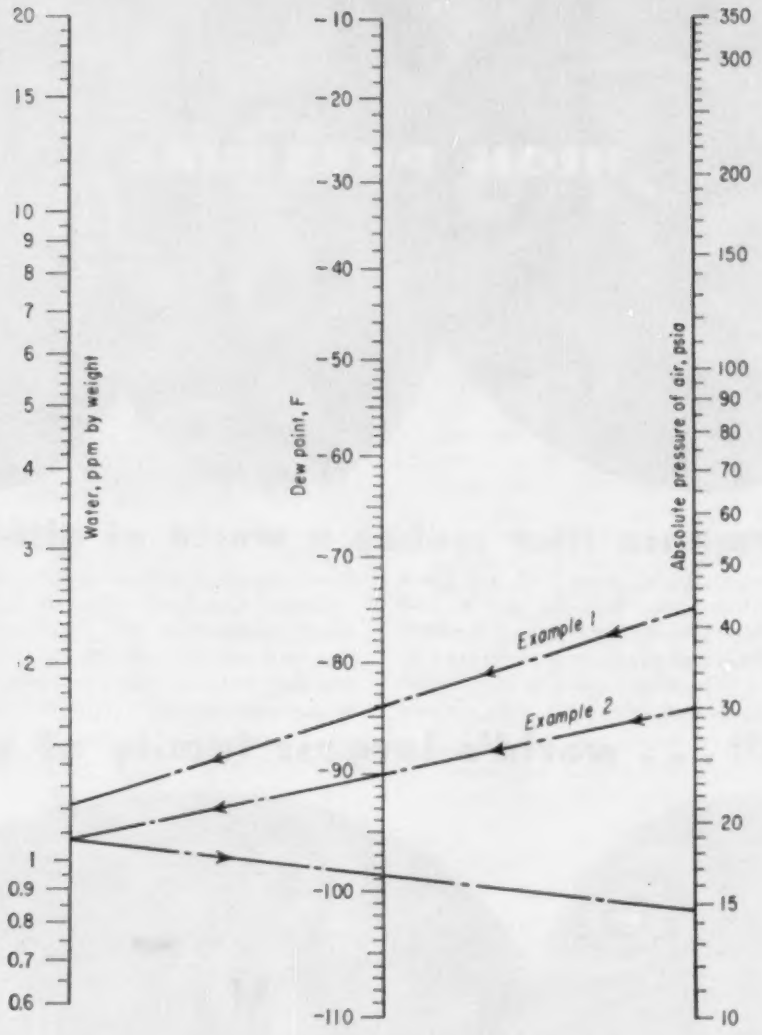
Power's data sheet

No. 335



Calculate dew point and water content of compressed air

Water content and dew point of compressed air can be important considerations in design of air systems. This nomogram is handy for finding the usual quantities required for design purposes.

Water content and equivalent dew point are found at atmospheric pressure. Note that multiplication of pressure scale by 10 must be accompanied by division of water weight by 10.

Example 1: What is the water content of compressed air having a dew point –84 F at 415 psig (430 psia)?

Align pressure of 430 (10 x 43) with dew point of –84 F and read water content of 1.22 ppm. Actual water content of the air then is 1.22/10 or 0.122 ppm.

Example 2: Air at 15.3 psig has a dew point of –90 F. What is its dew point after it has been expanded down to atmospheric pressure?

Align 15.3 + 14.7 = 30.0 psia with dew point of –90 F and continue to water weight. Extend line from weight to pressure of 14.7 psia and read intersection of dew-point line as –98.6 F.

F Caplan, *Oakland, Calif.*

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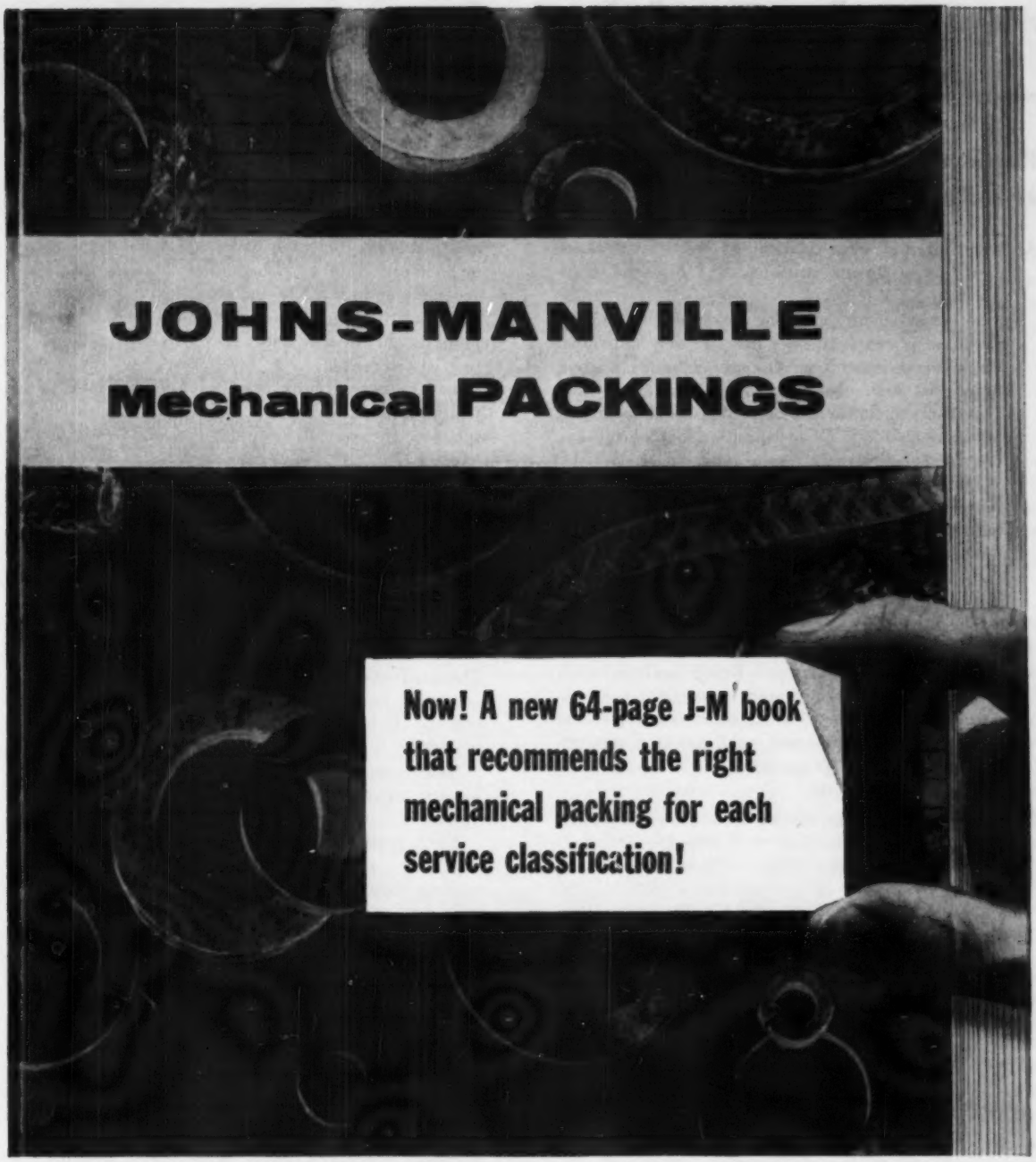
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Technical briefs ... Latest engineering

Russian power plants on their way to automatic control

Automation and organization of control in large unit type power stations, *D I Rabkina, Engineer, U.S.S.R.*

As yet automatic operating experience in Russian unitized power stations is limited—only individual components have been fully tested out. Current problems of automatic control fall into three groupings: (1) definition of objectives and selection of control circuits (2) organization of control (3) equipment selection.

Control-system requirements during internal and external disturbances are covered, including load-dump and turbine-trip. Automatic cold startup has not been fully studied, but it appears more feasible where unit systems are *not* used. Automatic hot restart seems to present greater difficulties. Only water-treatment plants and fuel-delivery systems should be excluded from automatic plans.

Instrument development in Russia has been rapid, but standard regulators and instruments available are unsatisfactory. Excellent electronic controllers available are not suitable in all cases. *Teploenergetika, 1959, No. 3 (5 pages)*

Tasks in the automation of new thermal-power stations, *P Ye Boloban, N I Davydov and V D Mironov, All-Union Thermo-Technical Institute, U.S.S.R.*

Although automatic control on once-through boilers is now achieved, little has been done in automatic unit control. Latter requires overall consideration of complete boiler-turbine-generator unit, and this has been difficult because each is made in a different factory without effective coordination.

Past work has concentrated on automatic control during periods of base-load normal operation; areas needing attention include automatic control during startup, shutdown, emergency situations and load swings. Automatic control of fuel-handling and water-treatment plants is hindered by lack of sufficient mechanization.

Some electronic equipment currently available for automatic control is not sufficiently reliable, particularly relays, magnetic starters and differential-pressure elements. Instrument design will be simplified if control and supervisory functions are separated. *Teploenergetika, 1959, No. 7 (3 pages)*

The prospects of increasing steam parameters and efficiency of power plants, *V Ya Ryzhkin and I N Tambiyeva, U.S.S.R.*

Currently 450-mw units are being developed in Britain, 550-mw in the United States and 600-mw in the Soviet Union. It appears quite possible to design and build multishaft machines of 1- to 2-million kw.

Steam generators of 3,800,000-lb-per-hr capacity are in service. But limit of ferritic steels seems to be 3550 psig, 1100 F. Using austenitic steels, plants are going up in U.S.S.R. and abroad with 5000-psig 1200-F initial conditions. Metallurgy and steam-property studies now under way cover the 14,000-psig 1850-F range.

Today's regeneration practice of 9 to 10 stages will have to grow to 13 to 17 stages with corresponding increase of feedwater temperatures—600 to 840 F.

Author predicts 4- to 6-million-kw plants made up of 1- to 1½-million-kw units. *Energetik, 1959, No. 8 (5 pages)*

Fire-resisting turbine oils, *K I Ivanov and Ye D Vilyanskaya, All-Union Thermo-Technical Institute, U.S.S.R.*

Fire-resistant synthetic oil developed by All-Union Thermo-Technical Institute for both lubrication and governing is based on organic phosphorous compounds. It has a self-ignition temperature in air of 1360 F, is not subject to foaming and isn't toxic at low concentrations. Tests show the synthetic has less adverse effect than mineral oils on normal insulating materials.

Since synthetic oil has higher specific gravity than water, changes are required in turbine-lubricating systems, especially for water drainage. Health considerations dictate that this synthetic oil should not be exposed at temperatures above 120 F. *Teploenergetika, 1959, No. 9 (4 pages)*

Vibration standards for turbo-machines, *N V Kruglov, U.S.S.R.*

Many vibration standards exist in Russia for steam turbines and turboblowers based on operating experience in the 3000- to 5000-rpm range. However, in the 25,000-rpm range all that can be said is that vibration should not exceed two microns. Existing standards are analyzed and plotted to show divergencies in allowable amplitudes of vibration.

Another measure of maximum-permissible vibration sets limits of acceleration or maximum ratio of acceleration to gravity. Some increase in this ratio should be permitted over the 1500- to 5000-rpm speed range. Basis of analysis establishes constant value for product of amplitude and speed. At 30,000 rpm, acceleration should not exceed 2 g's. Formula derived gives permissible amplitudes of 2 microns at 30,000 rpm and 0.0008 in. at 3000 rpm. While these values may be conservative, they shouldn't be relaxed until much more experience is gained. *Teploenergetika, 1959, No. 8 (3 pages)*

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BOILERS

Slag and ash removal from power stations of medium output, *N I Spiridonov, Engineer, U.S.S.R.*

Hydraulic ash-removal systems are most popular in Russia today, but pneumatic systems are now proposed for many new power stations. Mechanical methods are little used.

Comparative study of eight ash-removal methods, each for 50 tons per hr, reveals that capital costs for all hydraulic systems studied are about equal; pneumatic systems are appreciably lower. Operating costs tabulated vary with distance to dump and cost of water and power.

Conclusions: If health authorities require high degree of air purification, hydraulic systems are recommended. But if cyclone dust collectors will satisfy health authorities, pneumatic systems are best. If ash and slag can be used locally for construction, addition of an agglomeration plant will reduce operating cost and capital pay-out time considerably. *Teploenergetika, 1959, No. 9 (4 pages)*

Gas turbines

Gas-steam-power generation, *P F Martinuzzi, Stevens Institute of Technology*

Combined gas-turbine and steam-turbine cycles for power and energy can be classed three ways: (1) steam-gas cycles where steam-generator furnace is also gas-turbine combustion chamber (2) gas cycle where turbine exhaust makes hot water or steam for heating purposes and (3) gas-steam cycle where steam produced by gas-turbine exhaust heat generates power in a normal steam cycle.

Third cycle is least discussed in literature but holds great promise, especially when metallurgy permits higher gas-turbine operating temperatures. Closed gas cycles using helium and taking heat from nuclear reactors give higher rates of heat transfer and permit higher pressures—reducing size.

Several gas-steam cycles are discussed quantitatively. *ASME 60-GTP-6*

Considerations for gas turbines and their initial operating experiences at El Convento, *O H Pfersdorff, La Electricidad de Caracas*

La Electricidad de Caracas, a private utility, is completely isolated electrically. Organized in 1895 with 500-kw capacity, it now carries 255,000-kw peaks. Units have been added on basis of 25 to 30% of peak load, with their frequency based on maintaining a reserve over peak load equal to the two largest units, to cover spinning reserve and maintenance.

By 1954 addition of two 20,000-kw peaking units became desirable. They bought one Brown-Boveri and one General Electric gas turbine and installed them in a new remote-controlled station near load center. Acute initial-noise problems and their solution are detailed. Gas-turbine design details and operating problems are covered.

Total plant installation costs are given as $139 per kw based on 21,500-kw rating of each unit. Costs include land, substation, building, foundations, silencers, g-t equipment. *ASME 60-GTP-4*

Smoke reduction in residual-fuel-burning gas-turbine combustion system. *R B Schiefer, J B Gatzemeyer, N R Dibelius, General Electric Co*

Need to reduce smoke emission of gas-turbine-electric locomotives prompted studies and combustion-system redesign. All smoke-measurement equipment available was reviewed. The Von Brand smoke recorder and photocell was selected because results are independent of subjective evaluation, which can be extremely erratic.

Combustion-chamber investigations revealed desirable design features for operation on heavy No. 6 fuel with little or no smoke: (1) Size of local over-rich regions in the head end of combustion chamber must be kept as small as possible commensurate with good lean-limit blowout. (2) Dilution air must be introduced at a point far enough downstream to avoid quenching of incompletely burned carbon particles. (3) Care must be taken to avoid formation of secondary flows which carry smoke particles into cool-air streams where they bypass flame front and escape unburned.

Redesign of combustion chamber followed these requirements; field tests with several liners met smoke-abatement regulations. *ASME 60-GTP-7*

Maintenance

Maintenance of bulk-material conveying equipment, *C W Cassells and E J Kamp, Link-Belt Co*

Maintenance of conveying equipment, like any other machinery, begins on the drafting board. It is usually much less expensive to design ease of maintenance into a conveyor than to pay many times over when the machine is down. When buying equipment, make comparisons on the same maintenance-cost basis, or charge a penalty when design indicates high maintenance costs.

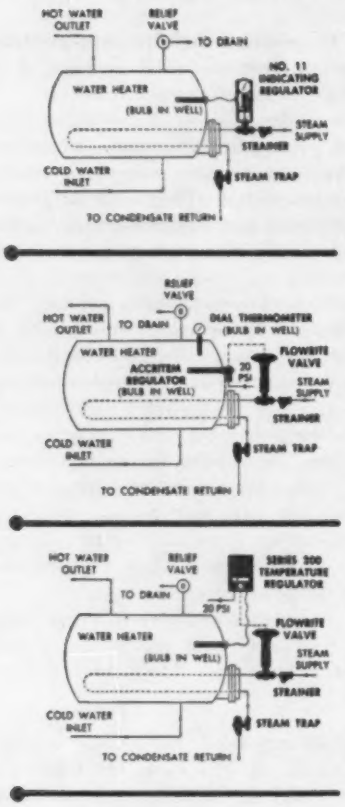
Many tips given on reducing conveyor maintenance include proper belt and conveyor-flight alignment, cleaning and lubrication. In each case suggestions should reduce rate of wear and prolong conveyor-system life.

A strong plea is made for upgrading the "grease monkey"—as presently regarded he can easily become a very expensive luxury. He's little appreciated, but it's a fact that he controls useful life of operating equipment. The influence of his skill (or more-prevalent lack of skill) on equipment wearout cannot be overemphasized. *ASME 60-MPE-5*

continued

Directions for ordering these papers on page 100

Practical Ways To Control Hot Water Storage Heaters



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Technical briefs

Begins on page 96

Maintenance men—important today—a necessity tomorrow, *J Vonderheide, General Electric Company*

Many "preplanned" maintenance programs have failed because industries have dived in without paying heed to their internal limitations. Result: a cost too high to be justified to management.

Maintenance program at General Electric's Appliance Park is built around personnel with broad maintenance classifications instead of more-usual craft specialties. This eliminates costly jurisdictional job disputes about who does what. Each man can and does perform tasks normally assigned to carpenters, electricians, millwrights, plumbers and others. Idle specialized-labor pools are gone. Maintenance men quickly develop diverse skills, increasing their individual value to the company. Union efforts to force reversion to craft specialties have been unsuccessful because men can see increased job security resulting from broad maintenance classification.

Economics of maintenance are hard to prove. But a balance sheet of cost vs "what will happen if maintenance is nonexistant" will go a long way in justifying expense. It establishes maintenance as a business within a business—with its own profit and loss statement. *ASME 60-MPE-6*

Boilers and auxiliaries

A pressure-fired spreader-stoker boiler and other novel features of an industrial power plant, *H H Reisman, Deere & Company*

Through expansion and land purchase, four separate factories of Deere & Company, Moline, Ill. have been integrated into one large plant with 6000 ft fronting the Mississippi River. Previously each factory had a separate power facility, but high cost of expansion and separate-facility operating cost indicated a new central power plant to serve entire site.

Integrated power facility includes: (1) compressed air (2) industrial

For more facts circle 246 on Reader Service card, p 103

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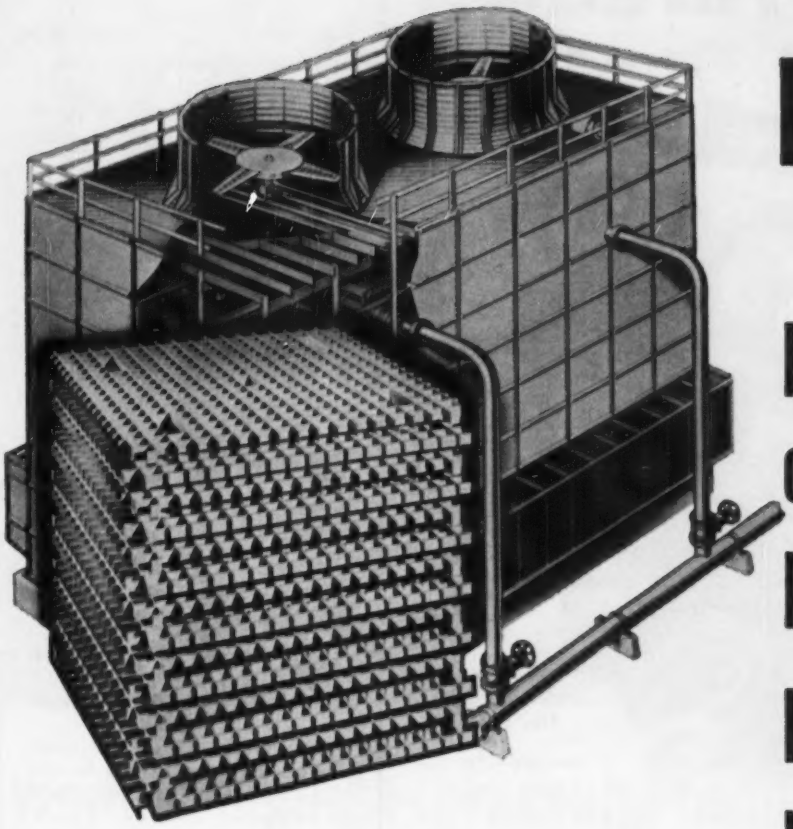

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Technical briefs

Begins on page 96

water (3) electrical generation and distribution and (4) heating and process steam.

Of particular interest in the plant itself is the pressure-fired spreader-stoker boiler — an industrial first. Advantages of this novel arrangement are: (1) elimination of induced-draft fan with attendant reductions in maintenance and power requirements (2) elimination of otherwise undetected setting air leaks through boiler pressure (3) simplified combustion control and (4) improved heat-transfer rates because of higher furnace-gas density.

Only initial operating difficulty (startup was Oct '59) was manually controlling the ash-handling system. Combustion-control equipment eliminated the trouble. *APC—1960*

To obtain complete text

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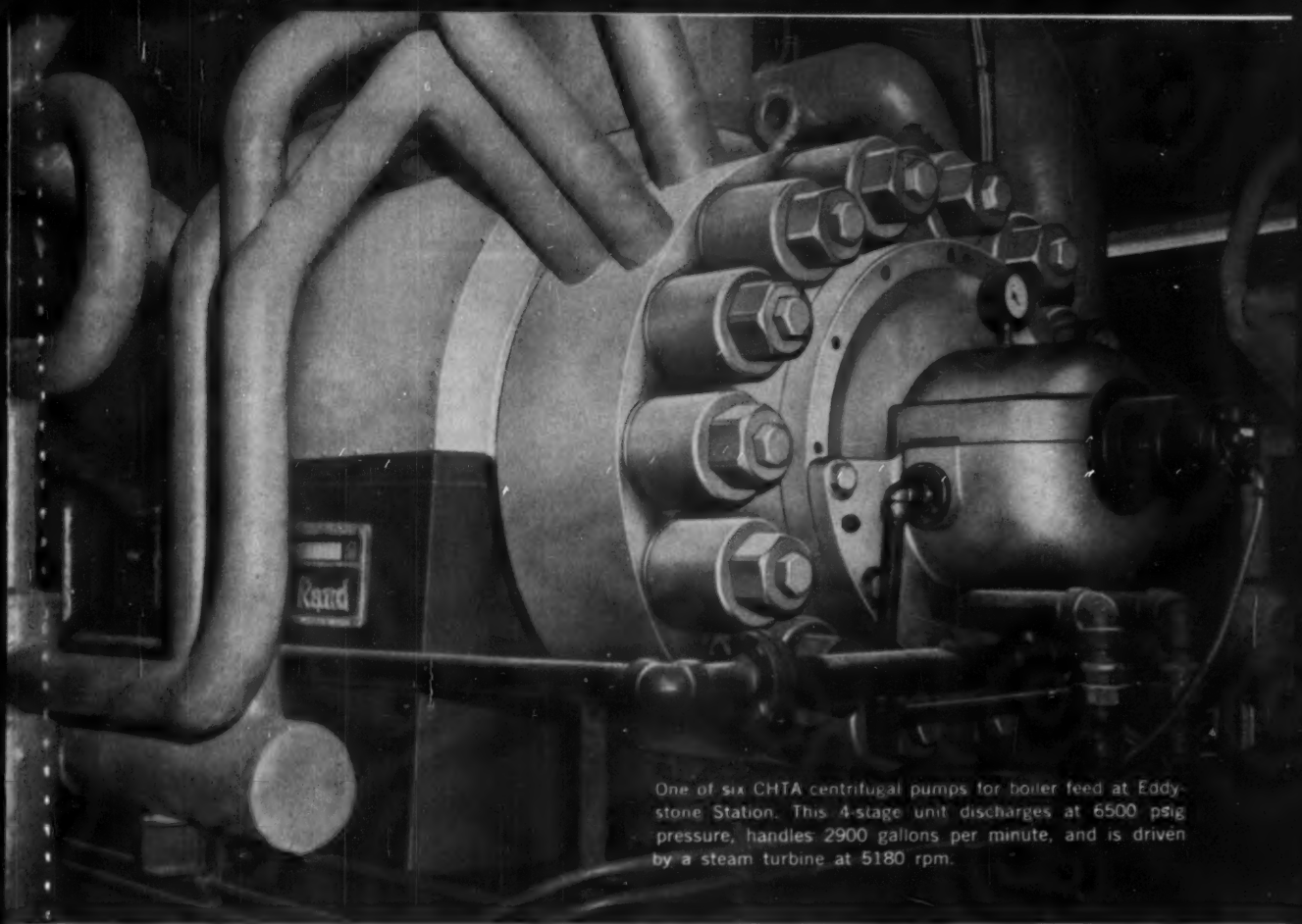
Russian papers. For complete English abstracts contact Office of Technical Services, U.S. Dept of Commerce, Washington 25, D.C. Price, 70c. For complete papers in Russian contact Chief, Photoduplication Service, Library of Congress, Washington 25, D.C. Price, $1.80 for 1 to 10 pages.

American Society of Mechanical Engineers. Contact ASME, 29 W 39th St, New York 18, N. Y. Members, 50c; nonmembers, $1.

American Institute of Electrical Engineers. Contact AIEE, 33 W 39th St, New York 18, N. Y. Members, 50c; nonmembers, $1.

National Association of Corrosion Engineers. Reprints will be available after publication in *Corrosion*. Contact NACE, 1061 M & M Building, Houston 2, Texas. Prices not established.

American Power Conference. Papers will be published in book form. Contact Illinois Institute of Technology, Technology Center, Chicago 16, Ill. Price, $8.00.



One of six CHTA centrifugal pumps for boiler feed at Eddystone Station. This 4-stage unit discharges at 6500 psig pressure, handles 2900 gallons per minute, and is driven by a steam turbine at 5180 rpm.

World's highest-pressure boiler feeders now on the line at Eddystone

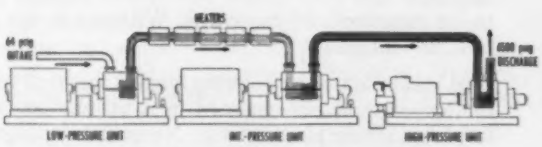
Six Ingersoll-Rand centrifugal pumps boost boiler feedwater from 64 to 6500 psig at "world's most efficient power plant"

Specifications for the 325,000-kw Unit No. 1 of Philadelphia Electric Co.'s Eddystone Station exceed those of any other power station ever built. Steam pressure is 5000 psi, steam temperature reaches 1200°F ultimately.

The Ingersoll-Rand centrifugal pumps handling the feedwater, which reaches a temperature of 574°F, are the highest-pressure boiler feeders ever built. Discharge is 6500 psig. There are two half-capacity systems, each consisting of low-pressure, intermediate-pressure and high-pressure pumps.

All of the I-R pumps are Class CHTA—single-suction, multi-stage diffusor-type units featuring symmetrical "double-case" construction and "unit-type" rotor assembly for dependable performance and minimum maintenance. The shaft, impellers and stationary channel rings are assembled as a compact, completely self-contained inner-casing unit.

For more information on the CHTA, contact your I-R representative. Or write for bulletin 7211-A.



Six I-R CHTA pumps are operating at Eddystone in two half-capacity systems, each consisting of three pumps in series as shown above.

A CENTURY 1860 — 1960 OF PUMP PROGRESS

Ingersoll-Rand

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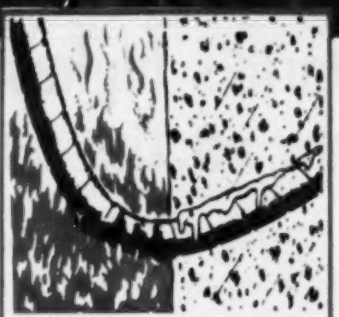

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New free literature

General equipment and key materials for systems engineering

• **Instruments**

101 **Digital information system** is described and illustrated in 8-p bulletin E72-3. Bailey Meter Company

102 **Remote-reading** electrical flowmeters for all types of liquids and gases at line pressures to 5000 psi are featured in 28-p publication 59-5. Principle and engineering features are described and illustrated. Rockwell Mfg Co, Republic Flow Meters Co

103 **Gas detectors,** portable, semiportable and multi-channel units are covered in 4-p folder 510-1. Houston Instrument Corporation

104 **Cause, effect** and control of water hammer in piping systems, flanged and silent check valves are discussed in bulletins available from The Williams Gauge Company, Inc

105 **Recording systems** for transmitting data to distant computer facilities via telephone circuits, firm's approach to industrial-process-control systems are covered in two bulletins. Daystrom, Inc, Control Systems Div

106 **Nondestructive-testing** equipment is topic of 12-p booklet giving facts and specs on X-ray test units. Philips Electronic Instruments

107 **Temperature and pressure** recorders are announced in 8-p catalog 800. Spiral-bourdon-tube and bellows type pressure elements are pictured with materials and performance characteristics listed. American Machine and Metals, Inc, U.S. Gauge Div

• **Insulations and coatings**

108 **Adhesives and coatings** for insulating applications and methods for selecting right product for insulation jobs are treated in 4-p folder. Insul-Coustic Corp

109 **Silicones**—summary of forms, properties and applications as release agents, laminating elements, rubber compounds, electrical insulation and water repellents—are detailed in 16-p brochure. Dow Corning Corp

110 **Modified polyester insulating** varnish for high heat resistance is featured in 6-p form SV-116. Schenectady Varnish Company

• **Piping and valves**

111 **Pressure hose** and couplings of all-synthetic construction for hydraulic and other high-pressure applications are featured in catalog NEPR-500. Minimum burst pressure is 9000 to 12,000 psi de-

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pending on size. The Imperial Brass Mfg Co

112 **Piping-systems** fabrication and erection for power stations and industrial plants throughout the country are highlighted in 24-p publication 60B. Midwest Piping Company, Inc

113 **Polyvinyl-chloride** and polyethylene pipe, high-impact styrene-alloy sewer pipe are featured in three new 4-p folders available from Keasby & Mattison Company

114 **Reference weight chart** for square- and rectangular-welded steel tubing is 4-p folder. Standard Tube Co, Michigan Steel Tube Products Div

115 **Engineering** of plastic piping systems for corrosion service is topic of 16-p handbook 1159. This includes chemical-resistance and physical-properties charts with recommendations. Chemtrol

116 **Complete line** of rubber hose for general industrial applications is subject of 24-p booklet. Descriptions of over 35 types of hose with illustrations, sizes, weights, ply working pressures are given. Mercer Rubber Co

117 **Steel flexible-wedge** disk gate valves, 150 to 300 lb with psi range from 40 to 720, are detailed in folder. Crane Co

118 **Valves, unions**—firm's complete line—are covered in 18-p detailed catalog. This supersedes all material previously published by Catawissa Valve and Fittings Company

119 **Eccentric-valve** bulletin 110 lists features, pressure ratings, dimensions, accessories and applications. Dezurik Corp

120 **General-purpose** valves for industry are covered in 40-p catalog 160. Flare fittings, shutoff valves, drain cocks, brass pipe fittings are also presented. Madden Brass Products Co

121 **Sliding-gate pressure** regulators, 210 nozzle, are featured in catalogs J160-1 and F-210 available from OPW-Jordan

• Welding

122 **Preheat** for quality welds on high-performance steel is topic of 4-p folder. Describes building-block and electrical-strip-heater system. J B Nottingham & Co, Inc

123 **Which welding process** for the new metals?—topic of reprint available from Air Reduction Sales Co

124 **Instruction manual** describes operation and use of carbon-arc-welding process. Applications are illustrated. Arcair Co

125 **Gas-shielded** metal-arc-welding equipment both manual and auto-

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matic, firm's complete line, is covered in 20-p bulletin 2350. Manual gun for using CO_2 as a shielding gas is described and illustrated. Air Reduction Sales Company

126 **Tungsten - inert - gas - welding** process equipment, firm's complete line, is given in 24-p catalog 2300. This contains info on accessory equipment, tungsten electrodes and filler wires used with this system. Air Reduction Sales Company

• Prime movers

127 **M-d turbines** for pumps, compressors, fans and blowers, single-stage types DP and DR, are covered in 16-p bulletin GEA-4955C. General Electric Company

128 **Peaking combustion-gas turbines** with 7000- to 28,000-kw range are described in 12-p brochure GED-3761. Operating characteristics, automatic-operation features of the gas turbine are covered. General Electric Company

Air-conditioning systems

• Air conditioning

129 **Aquatowers,** double-flow type for operational load and wind pressures of 20 psf, have specs, engineering data listed in 4-p bulletin. The Marley Company

130 **Profitable investment** in factory air conditioning is topic of booklet prepared by Carrier Corp

131 **Starters** for central air-conditioning applications with voltage ratings ranging from 208 to 4900 are discussed in 8-p bulletin 8630. Square D Co

132 **Multizone** air conditioners are described in 4-p bulletin 8625. Drawings illustrate available arrangements and location of basic elements. American-Standard Industrial Div

133 **Multizone air conditioners** are announced with engineering data, dimensions and specs in revised catalog 55c9a. Recold Corp

• Ventilation

134 **High-energy** dust and fume scrubber featuring small size, efficiency even in submicron-particle-size range is covered in 4-p bulletin W-8560. The Ducon Co

135 **Cube type** replacement air filter reduces filter-bank face area by more than half. Details are in 4-p booklet B. Union Carbide Development Company

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A Nalco PRODUCT MANAGER

Answers Basic Questions on Coagulation of Solids in Potable, Process and Waste Waters

New Chemicals and New Techniques Mark Advances in Solving A Frequent Plant Operating Problem

Improved methods of chemical clarification are constantly being developed, tested, and put into full-scale commercial use. Here are answers to some of the questions we hear frequently in this area of Nalco service activity.

Question: What is coagulation?

Answer: Coagulation is the agglomeration—chemical gathering together—of the very fine solid particles suspended in water. These particles create turbidity, coloring, and some types of odors.

Question: What are the advantages of coagulation over sedimentation?

Answer: Speed, more effective clarification, and smaller capital equipment investment are all advantages of coagulation over sedimentation.

Question: Are all coagulation requirements the same?

Answer: No. In some cases, a high degree of sparkling clarification is essential. In others, a lesser degree of clarification is satisfactory. Sometimes, the removal of color is the only job to be done. Seasonal and other changes in water and turbidity characteristics also change the type and amount of treating necessary. Overall quality of the water must be compatible with the end-use requirements—not based on a fixed "cure-all" treatment program.

Question: What are the characteristics of a good coagulation program?

Answer: Continuous production of water of the necessary clarity and quality to meet end-use requirements; with the flexibility to handle changing conditions in input water characteristics. A good coagulation program should also increase the length of filter runs.

Question: Historically, what coagulant chemicals have been used?

Answer: Most common chemicals used as coagulants were: iron salts, alum (aluminum sulfate), and lime (calcium hydroxide).

Question: What are some of the more recent improvements in the field of coagulation?

Answer: Sodium aluminate is probably the first of the "modern" coagulants. It supplies an alkaline source of alumina with a negative (anionic) charge, and constitutes a coagulant which ideally meets the requirements of principal coagulation process uses—frequently with alum, to improve flocking and give faster settling rates at lower overall costs.

Natural and synthetic organic polymers are the most recently-developed coagulant chemicals. They are high molecular weight materials which are anionic, cationic, or nonionic; and function as high-efficiency coagulant aids. Or, as is true with the cationic polyelectrolyte developed by Nalco, they may function as both coagulants and coagulant aids. Use of these materials provides greatly increased floc particle size and weight, resulting in increased clarity, longer filter runs, and increased throughput rates.

Question: Will any of these newer coagulant chemicals solve all clarification problems?

Answer: No. There is no all-purpose coagulant chemical; nor is there likely to be one. Too many variables enter into the choice of proper chemicals to fit specific operating conditions: from the type of influent water through kinds and arrangements of equipment to the clarity needs of effluent water.

J. T. Burke, Manager
Nalco Coagulation Chemicals Department

Question: What is the best approach to solving a specific coagulation problem?

Answer: Take all the factors involved, and accumulate specific information on them: (a) Make a thorough investigation of the supply water, the equipment employed, the end use of the water, and the performance characteristics of chemicals available for coagulation and coagulation aid. (b) Test coagulation with various chemicals by beaker tests and other laboratory evaluation techniques. Evaluation should include analysis of waters produced, to make certain that the quality is compatible with end-use requirements. (c) Get the advice and assistance of experts as to methods and locations of applying chemical treatments to get maximum coagulation efficiency.

Question: Does Nalco provide the experts to gather this information?

Answer: Yes—in addition Nalco supplies the most complete line of coagulants and coagulant aids in the industry.

Question: How is Nalco qualified to help solve coagulation problems?

Answer: Nalco's basic background is successful water treatment. The Coagulation Chemicals Department at Nalco is made up of "specialists' specialists": men whose sole job is to provide Nalco Representatives and their customers with the materials and assistance necessary to solve coagulation problems.

No other organization has more experience or better facilities to solve *your* coagulation problem, promptly and economically. Call or write for action now.

NALCO CHEMICAL COMPANY
6222 West 66th Place • Chicago 38, Illinois
Subsidiaries in England, Italy, Mexico, Spain, Venezuela and West Germany
In Canada—Alchem Limited, Burlington, Ontario

nalco® ...Serving Industry through Practical Applied Science

Nalco CHEMICALS
Nalco SERVICES

For more facts circle 251 on Reader Service card, p 103

BELMONT

Ajax Spiralwound
FLANGE and BOILER GASKETS

No waiting for the popular types and sizes of spiralwound flange and boiler gaskets. Belmont backs their Distributors in 132 key industrial areas with stocks on hand for immediate shipment.

TYPE SR with steel centering ring for raised face, Van stone and lapped joints. All nominal pipe sizes from ½″ through 24″ in pressure ranges from 150 psi through 600 psi; and from ½″ through 12″ in pressure ranges to 2500 psi.

TYPE H with loop centering guide for raised face, Van stone and lapped joints. All nominal pipe sizes from ½″ through 24″ in pressure ranges from 150 psi through 600 psi (except 400 and 600 psi gaskets above 8″, for which services Type SR Gaskets are stocked).

TYPE MH and CR Boiler manhole gaskets in 3 pressure ranges—to 499 psi, to 999 psi and 1000 psi and above. Sizes 11″ x 15″ and 12″ x 16″ in flange widths from ¾″ to 15/16″.

TYPE A for boiler handholes and tube caps in 3 pressure ranges—to 499 psi, to 999 psi and 1000 psi and above. Most popular sizes for Babcock & Wilcox, Combustion Eng., Edgemoor, Erie City, Foster Wheeler, Heine, Keeler, Union and Vogt boilers.

Ask your nearest Belmont Distributor for a complete stock list. You will find him in our insert in the Packing Section of Conover-Mast Purchasing Directory.

BELMONT

The Belmont Packing & Rubber Company • Butler & Sepviva Sts., Phila. 37, Pa.

Free literature

Begins on page 103A

136 **All-purpose** centrifugal fans are topic of 76-p catalog describing complete line. Key components and features are well illustrated; tabular performance data and dimensions are included. Westinghouse Electric Corporation, Sturtevant Div

137 **Glass-bag filters** to end hot, corrosive dust headaches are topic of 12-p bulletin 806. Cleaning of bags is described. Fuller Co, Dracco Div

138 **Reverse-jet** dust collector with fabric filter bags eliminates rubber-hose wear. Dust-control bulletin 279C tells story. American Air Filter Co, Inc

139 **Exhaust purifiers** for oxidizing CO, fumes and odors from gasoline, lp-gas and diesel-powered equipment are covered in 4-p folder. Oxy-Catalyst, Inc

140 **Dirt and dust control** by Statronic system, electronic method for particulate bombardment and negative ionization, is described in folder. CRS Industries, Inc

141 **Propeller fans,** low-speed and high-volume types, are covered with specs and sizes listed in 4-p bulletin A-109E. Hartzell Propeller Fan Company

142 **Extended-surface** air filter has high air-cleaning efficiency, large dust-holding capacity. Bulletin 601 ES gives details. Arco Mfg Co

Gas systems

143 **Air compressors** for standard 110-psi applications are topic of 16-p bulletin 185. Sizes range from 75 to 2000 bhp. Clark Bros Co

144 **Reversible expanding turbine** for gas-pipeline valve applications has 1- to 45-hp rating with 1000-psig maximum inlet pressure. Details are in 2-p bulletin. Dean Hill Corp

145 **Air cylinders,** air-hydraulic boosters, air-oil circuits, high-speed cushions are covered in 24-p catalog P2547P. Mounting and dimensional data permit easy selection of bore sizes; a section covers company's services. Flick-Reedy Corporation

146 **CO_2 and its value** to industry is explained in 24-p booklet. This covers history, applications, properties, manufacture, supply and distribution, regulating equipment and controls for CO_2. Air Reduction Company, Inc, Pure Carbonic Company Div

147 **Gas chromatographs** have construction details and specs, performance and operating features, applications listed in 12-p bulletin GC-4018. Beckman Scientific and Process Instruments Div

continued

ALLIS-CHALMERS

A-1233

Allis-Chalmers 215,000 lb./hr. tray deaerator with 7200-gallon horizontal storage tank at a southern chemical plant.

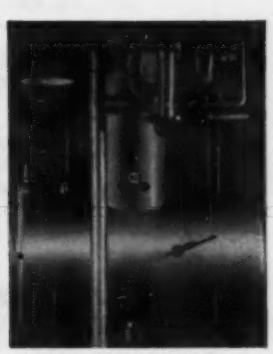
Corrosive gases removed

from boiler feedwater with Allis-Chalmers deaerators

Positive corrosive gas removal by Allis-Chalmers tray-type deaerators is proved by a pilot unit (below) equipped with a continuous oxygen analyzer and recorder. It utilizes unique counterflow design for thoroughly scrubbing dissolved gases from the water surface. Design produces maximum heating of water with minimum of steam loss in venting. Effective deaeration is guaranteed under all loads.

Ruggedly constructed, A-C deaerators employ 16-gauge 18-8 stainless steel on all equipment exposed to corrosive gases. No moving parts assures quiet operation, minimum maintenance. Inspection is easy through ample access doors and manholes. Service? Seventy-seven district offices throughout the nation. Your A-C water conditioning engineer can give you full deaerator details. **Allis-Chalmers,** Power Equipment Division, Milwaukee 1, Wisconsin.

Pilot deaerator permits evaluation of tray designs.

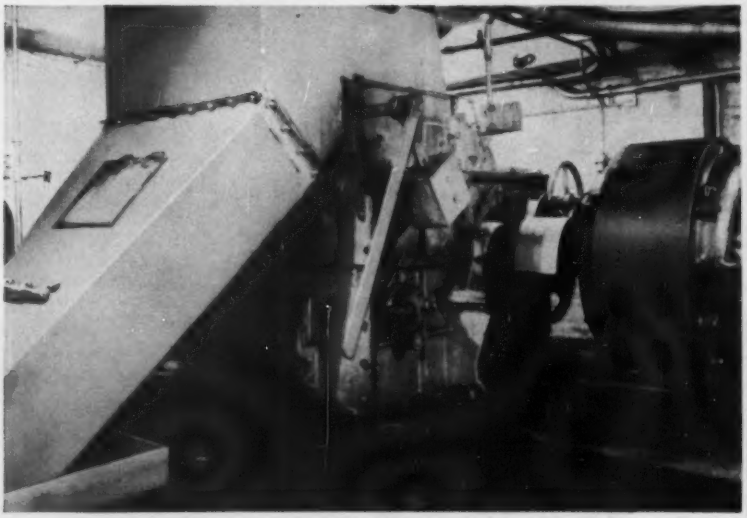


"Standard" deaerators for small industrial power plants.

For more facts circle 253 on Reader Service card, p 103

CRUSHING FACTS

from *American* PULVERIZER CO.



USER REPORT

"7,000,000 TONS OF COAL reduced to 3/4" by this crusher, and it is still going strong"

After 23 years of operation, this American AC Rolling Ring Coal Crusher is still giving excellent service.

Replacement parts, plus standby parts, for reducing 7,000,000 tons of coal have cost less than 1/5 of a cent per ton. **Quality is proven only by performance.**

There are solid engineering reasons for this performance. The crushing elements, composed of American-originated rolling shredder rings, split coal instead of crushing it. This means less wear on screens and liners, less attrition in the crushing chamber. The rings are manganese steel and are reversible to give double wear. Liners are easily replaced.

The entire rotor assembly and bearings are so carefully machined, aligned and balanced that a nickel will stand on edge when the crusher is operating!

You can depend on performance like this when you use an American Coal Crusher. Our engineers will advise you on the correct model for your reduction problem.

American PULVERIZER COMPANY

ORIGINATORS AND MANUFACTURERS OF RING CRUSHERS AND PULVERIZERS

1349 MACKLIND AVE. ST. LOUIS 10, MISSOURI

6005

Free literature

Begins on page 103A

Electrical systems

• Generation and conversion

148 **De power savings** for electrochemical industry with silicon rectifiers is topic of 20-p booklet B-7900. Westinghouse Electric Corp

149 **Solid-state** conversions are topic of brochure covering new systems and components. Cook Electric Company

• Distribution and protection

150 **Load-center** unit substations providing continuous power for ac-distribution systems—300 to 3000 kva, 600 v and below—are introduced in 32-p bulletin GEA-3592L. Types of load-center arrangements and selective coordination of load centers are discussed and compared. General Electric Co

151 **Bus-duct application** data for plug-in high-frequency and electric-utility bus ducts is contained in 12-p booklet 30-660. Westinghouse Electric Corp

152 **Circuit-breaker** load centers, 150 and 200 amp, are described in 16-p bulletin. General Electric Co

153 **Circuit breakers, low-voltage** and molded-case types, are presented with features and advantages described in 16-p bulletin SB-CB-1. Multi-Amp Electronic Corp, Multi-Amp Div

154 **Wire and cable** for control, power and portable power are described in 52-p catalog WC-859. Physical properties of insulating materials are covered. Walker Brothers

155 **Workbook** to aid in planning unit substations for secondary distribution includes ratings, weights and dimensions. Types of load centers and substations for indoor and outdoor applications are described. McGraw-Edison Company, Pennsylvania Transformer Div

156 **Capacitors** for reducing power costs are introduced in 12-p booklet B-7642. Westinghouse Electric Corporation

157 **Conductors** and electrical joint compound for aluminum bus conductors are treated in 100-p revision and performance report. Revision lists 10,000 available charts on sag and tension for covered, bare and steel-reinforced aluminum conductors. Alcoa

• Application

158 **Value of floodlighting** is discussed in 10-p bulletin GEA-7201. Application data on filament, mercury-vapor and fluorescent units is given. General Electric Company

continued

For more facts circle 254 on Reader Service card, p 103

ALLIS-CHALMERS

One of the compact groups of A-C rubber-seated butterfly valves at the pumping station of a southwestern municipality.

The right valve "repeats itself"

66 Allis-Chalmers rubber-seated butterfly valves line up to prove it

Economical, dependable, easy to operate: Allis-Chalmers rubber-seated butterfly valves give you these and so many more advantages that it's easy to appreciate their universal popularity. Full body protection is provided by a rubber seat which extends through the valve body and over the flange faces. Angle seating protects the rubber seat and permits seating adjustment without costly disassembly.

A-C manufactures a complete line of metal and rubber-seated butterfly valves in a wide range of types and sizes in order to provide the best valve for a given application. Compact design joins with light weight to bring other savings in both space and cost of construction.

• • •

For details on butterfly valves, cone valves and ball valves, contact your A-C representative or write **Allis-Chalmers,** *Hydraulic Division, York, Pa.* A-1309

Save Thousands of $$$ On Engine Maintenance and Lubrication
-- for only $129.50
West - slightly higher

SIMPLEX
PORTABLE OIL TESTING KIT
Patented in U.S.A., Canada, England

REVEALS DANGEROUS OIL CONDITIONS IN ENGINES OF ALL TYPES AND SIZES!

ACCURATE! EXCLUSIVE! Only commercial unit that meets U.S. Gov't. standards for oil testing! Used by leading manufacturing, transportation, construction, oil, marine firms; Government agencies.

HOW KIT SAVES YOU MONEY

1. REDUCES OIL AND FILTER CHANGES. Takes guesswork out of costly maintenance! Tells if engine can safely run additional hours or miles before changing oil and filter! Saves money on labor, lubricants! Warns if worn-out oil is shortening engine life.
2. DETECTS CORROSIVE ACID, DIRT, FUEL DILUTION AND WATER. Reveals early presence and degree of damaging contaminants—immediately! Warns of impending engine failure, helps avoid major overhauls, cuts repair costs!
3. HELPS AVOID BREAKDOWNS, BIG REPAIRS. Indicates condition of fuel injectors, automatic chokes, carburetors, gaskets, thermostats, piston rings, engine block, before expensive repairs are needed! Makes engines more efficient.

QUICK! EASY! ECONOMICAL!
Non-technical personnel can complete tests in 5 minutes, at a cost of only 5c—wherever the engine is operating! No calculating! No costly outside lab fees! Portable Simplex Kit contains easy instructions and all materials for 300 tests.

MONEY-BACK GUARANTEE!
Use the Simplex Kit for 30 days, compare it against any laboratory analysis. If you're not fully satisfied with its performance, your money will be refunded at once!

ORDER TODAY! Send check for $129.50 and purchase order to

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BOX 126 ANNAPOLIS, MARYLAND

Write for free brochure.
*Names given upon request.

Free literature

Begins on page 103A

159 **Motor-application** guide for 1/20 to 400-hp motors shows how to match load requirements with motor characteristics. Guide 270B has 16 pp. Century Electric Co

160 **Speed drives,** ¾ to 4 hp, feature dc motors which can be powered from electronic panel controlled by control-station operator. Details are in 4-p bulletin 101. The Louis Allis Company

161 **Liquid silicon rubber** (room-temperature vulcanizing) used in electrical assemblies as a sealing coating, impregnating and bonding compound is described in 12-p bulletin CDS-226. General Electric Company

162 **Motor drives** rated 1/40 to three hp feature sensitive feedback controls which reset automatically for speed changes. Details are in 4-p bulletin V-1. Electronic Controls Incorporated

163 **Limitrak—surface-coating** insulating material for electrical equipment—is covered in 8-p brochure MB-1908-A. Westinghouse Electric Corp

164 **Induction motors** are topic of selection, application and buying guide GEC-1049. Tables give dimensions, prices, performance data. General Electric Co

165 **Lighting equipment,** firm's complete line, is described in 28-p condensed catalog. Price list is included. Steber Mfg Company

166 **Stepping motor** and indexing device is described in 4-p brochure G-360-1. Ledex, Inc

167 **Electrical-resins** selector gives info on physical, mechanical, thermal and electrical properties for each resin system used in potting, impregnating and coating electrical assemblies. Marblette Corp

168 **Mercury lamp** with built-in metallic reflector, phosphor coating and hard glass is topic of bulletin 89. Radiant Lamp Corp

169 **Conformal casting** of motors, transformers and printed circuits is topic of new bulletin. Covers methods of forming molds for casting resins by vacuum-drawing heated thermoplastic sheets over electrical components. Minnesota Mining and Mfg Co

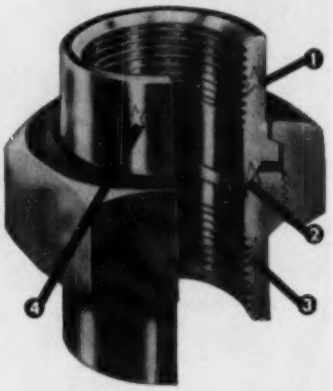
Steam, hot-water systems

• **Boilers**

170 **H-t water generators** are described in 16-p brochure 1600 which explains LaMont principles of forced recirculation. Boiler diagrams of installations are included. International Boiler Works Co

continued

only
CATAWISSA
gives you all these features for your forged steel pipe union requirements



1. **Uniform walls** for even expansion and contraction under temperature changes. They follow the pipe!

2. **Catawissa Ball-to-Angle Seats** give you a "Perfect Seal" regardless of pipe alignment!

3. **More than adequate** wall thicknesses give you Catawissa's 3-to-1 Safety Factor (3000-lb. service, 9000-lb. test; 6000-lb. service, 18000-lb. test)!

4. **Round, straight barrels** for fast wrenching. No uneven or tapered surfaces to cause wrench slips or wrench locking!

Catawissa Perfect Seal Pipe Unions are made by Union Specialists from 80,000 lb. tensile strength steel (ASTM Spec. A-105-55T, Grade II). Steel forgings from our own forging mill are closely checked for imperfections . . . and finishing on modern, automatic machines with close inspection during and after production give you pipe unions second to none!

Write for Catalog 60 showing the complete Catawissa line of Perfect Seal Products.

for complete, guaranteed satisfaction

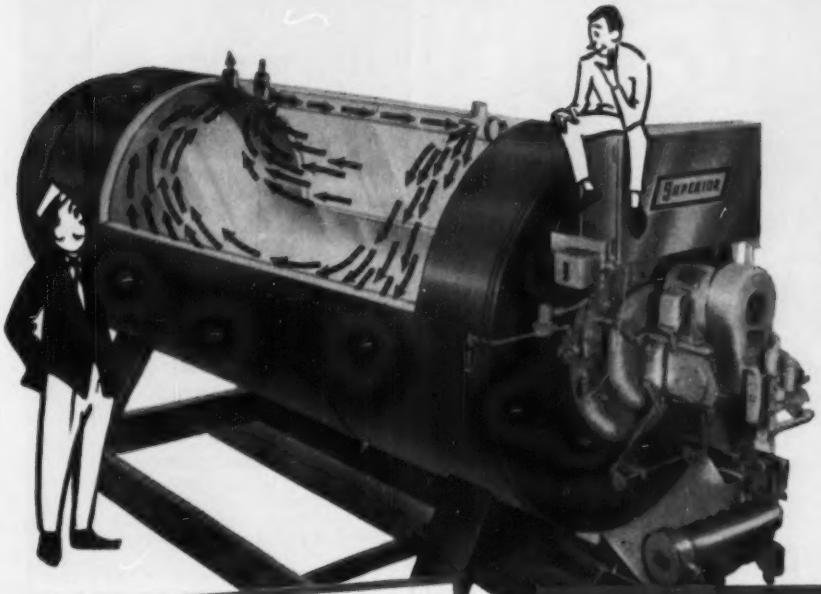
. . . always specify
CATAWISSA

CATAWISSA VALVE & FITTINGS CO.
CATAWISSA • PENNSYLVANIA

circle 256 on Reader Service card, p 103

circle 257 on Reader Service card, p 103

look what's happened to hot water boilers!



No, we're not making them with windows . . . we did that in the illustration to show you our NEW Venturi-action Mixing Tube which is the talk of the industry.

Venturi-Action Mixing Tube plays a triple role:

1 It starts by mixing entrained water from the boiler with water entering the boiler.

2 Traveling through the tube, the temperature is further modified by the surrounding water.

3 Jet action at the end of the tube directs flow downward and outward against the outer confines of the shell, providing a circulation pattern unequalled in any other hot water boiler.

SUPERIOR "TYPE CC"

Simple as it is, the importance of this NEW Venturi-action Mixing Tube can hardly be over-emphasized; for hot water boilers in many types of installations are subjected to rapid and extreme changes of water temperature. When the distribution of cool water is not completely equalized, the resulting expansion and contraction of the boiler causes stresses and strains which have become known as Thermal Shock.

No hot water boiler can be made to withstand severe and repeated Thermal Shock . . . but this new Superior Boiler is designed to reduce it to a minimum.

Available in sizes to 600 BHP, Superior's Hot Water Boiler is the answer to trouble-free hot water heating.

For details of Superior's Hot Water Boilers in sizes to 350 BHP write for catalog CCW-11. For sizes from 400 to 600 BHP write for catalog CFW-11.

Specialists in PACKAGED BOILERS... exclusively

SUPERIOR COMBUSTION INDUSTRIES, INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 36, N.Y.

SUPERIOR PACKAGED BOILERS

For more facts circle 258 on Reader Service card, p 103

(Advertisement)

LEARN LATEST

VIKING SALES PERSONNEL ATTEND FACTORY SALES AND ENGINEERING SEMINARS.

You can buy a **VIKING** Pump with confidence because the man selling it really knows how to apply the best pump to your particular pumping problem. Yes, your **VIKING** sales technician is well-trained and experienced, and a student of new pumping applications. He attends factory sales and engineering seminars, like the one shown above, to review facts and secure new data on standard and special pumps. He keeps up to date on the latest models and improvements.

Yes, you can place your confidence in the **VIKING** salesman and the **VIKING PUMP**—engineered for your pumping problems. For information, send today for catalog 60 SW. **VIKING PUMP COMPANY,** Cedar Falls, Iowa, U.S.A. In Canada, it's **"ROTO-KING" PUMPS.**

See Our Catalog In Sweet's Industrial Construction and Plant Engineers File.

For more facts circle 259 on Reader Service card, p 103

Here's why you're money ahead

with A. O. Smith glass-protected smokestacks

- Now available in a variety of colors
- They last longer — as much as 3 to 5 times longer than unlined steel stacks — corrosion resistant regardless of excess condensate
- Glass is tough, durable — shows remarkable resistance to impact or abrasion
- Maintenance is low! There's no painting—glass can't rust
- Economical to install — no need for special equipment or highly skilled workmen

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Through research ...a better way

A.O.Smith CORPORATION

SMOKESTACK SALES
PROCESS EQUIPMENT DIVISION
P. O. Box 584
Milwaukee 1, Wisconsin

Free literature

Begins on page 103A

171 **Water-tube boilers,** water heaters and applications are covered in 4-p bulletin 4011. Units are portable. Vapor Heating Corp

183 **Correct procedure** for removing boiler from line is topic of booklet describing new methods. Betz Laboratories, Inc

• Furnaces and burners

172 **Gas burners** with capacities from 100,000 to 3,600,000 Btu per hr are announced in 4-p catalog G-100-B. The Mettler Co, Inc

173 **Gas-fired** or electric box type recirculating furnaces with 300 to 1400-F range are discussed in 4-p bulletin SEC-8. Sunbeam Equipment Corp

• Fuel and fuel handling

174 **Stoker moves** and feeds fuels by intermittent vibration of water-cooled grate. Details are in well-illustrated 16-p bulletin S-546-A. United Industrial Corporation, American Engineering Co Div

175 **Chain-grate stokers** and incinerator stokers are featured in two 4-p bulletins from Illinois Stoker Company

176 **Reference chart** to facilitate ordering grades of coal gives info on where it's produced, shipping facilities and sizes made. Eastern Gas and Fuel Associates

177 **Pneumatic flyash-disposal** methods are detailed in folder ER-49-3. Fuller Company

178 **Method of removing water** from filter cake in coal preparation, using a gas-fired infrared heat source, is detailed in 16-p report 5473. Method is said to halve cost of conventional thermal drying. Government Printing Office

• Distribution and control

179 **Heavy-duty coils** for steam distribution are featured in 44-p brochure B-1518. Discussion of materials and contruction, layout drawing are included. American-Standard Industrial Div

180 **Steam traps,** forged-steel types for steam tracing and instrumentation, are discussed in 4-p bulletin 200. Velan Steam Specialties, Inc

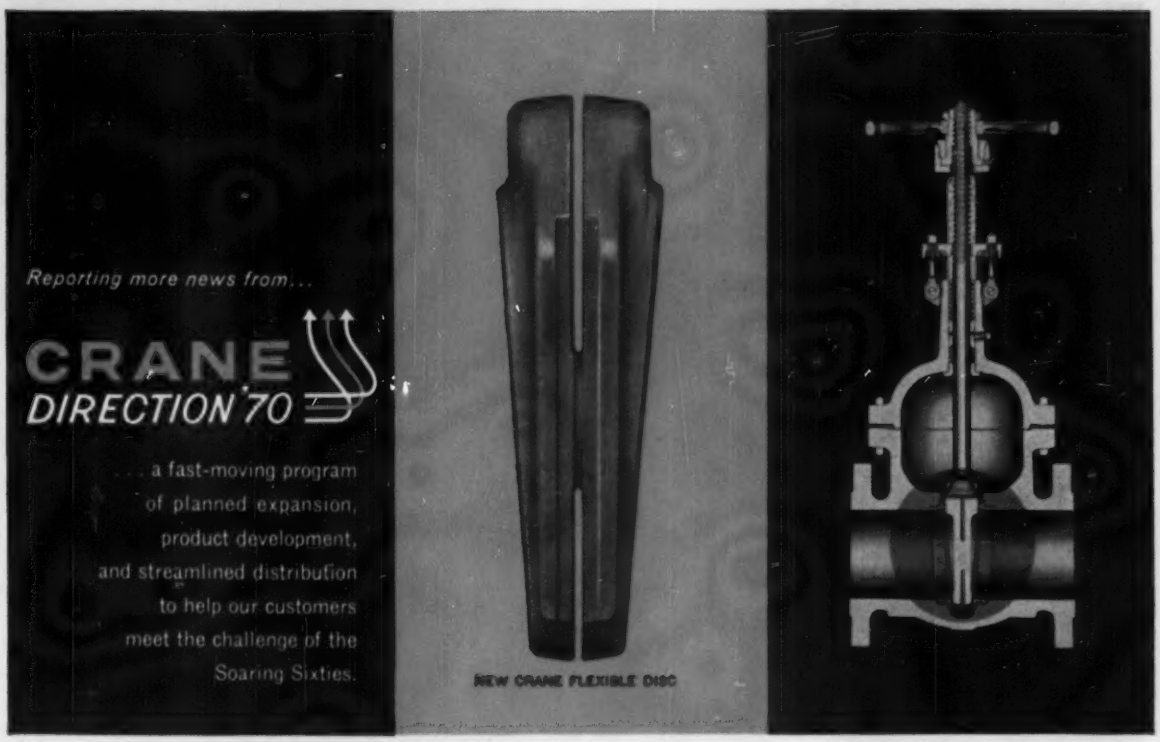
Liquid-handling systems

• Water treatment

181 **Portable chlorinator** is described in data sheet D-60-1. Milton Roy Company

182 **Sludge collectors** are detailed with sectional drawings and photos of layouts in 6-p bulletin 6751. Yeomans Brothers Co

For more facts circle 260 on Reader Service card, p 103



The most significant advance in gate valve design in 25 years...

CRANE FLEX GATES®

Instead of being made with a solid disc, new, patented Crane Flex Gates have separate disc faces, connected by the axle-like unit shown in the cross section. This joins the two seating faces, yet provides flexibility for the faces to seat tightly with independent action.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates seat with less torque.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates unseat with less torque . . . will not stick closed even when closed while hot and allowed to cool.

BECAUSE THEY'RE FLEXIBLE, minor deflection of seating faces due to pipe strains does not affect tightness of Crane Flex Gates.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates are tight on inlet seat and outlet seat over a wide range of pressures.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates can be used singly in some services where two conventional gate valves are frequently specified. You can save substantially on piping costs.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates can be serviced—body seat rings replaced or seating faces refinished—quickly, and without painstaking accuracy. Slightly off-taper seats do not affect tightness or operating ease.

BECAUSE THEY'RE FLEXIBLE, new Crane Flex Gates will easily outperform any conventional solid wedge disc valve you now use. *And there's no increase in price.*

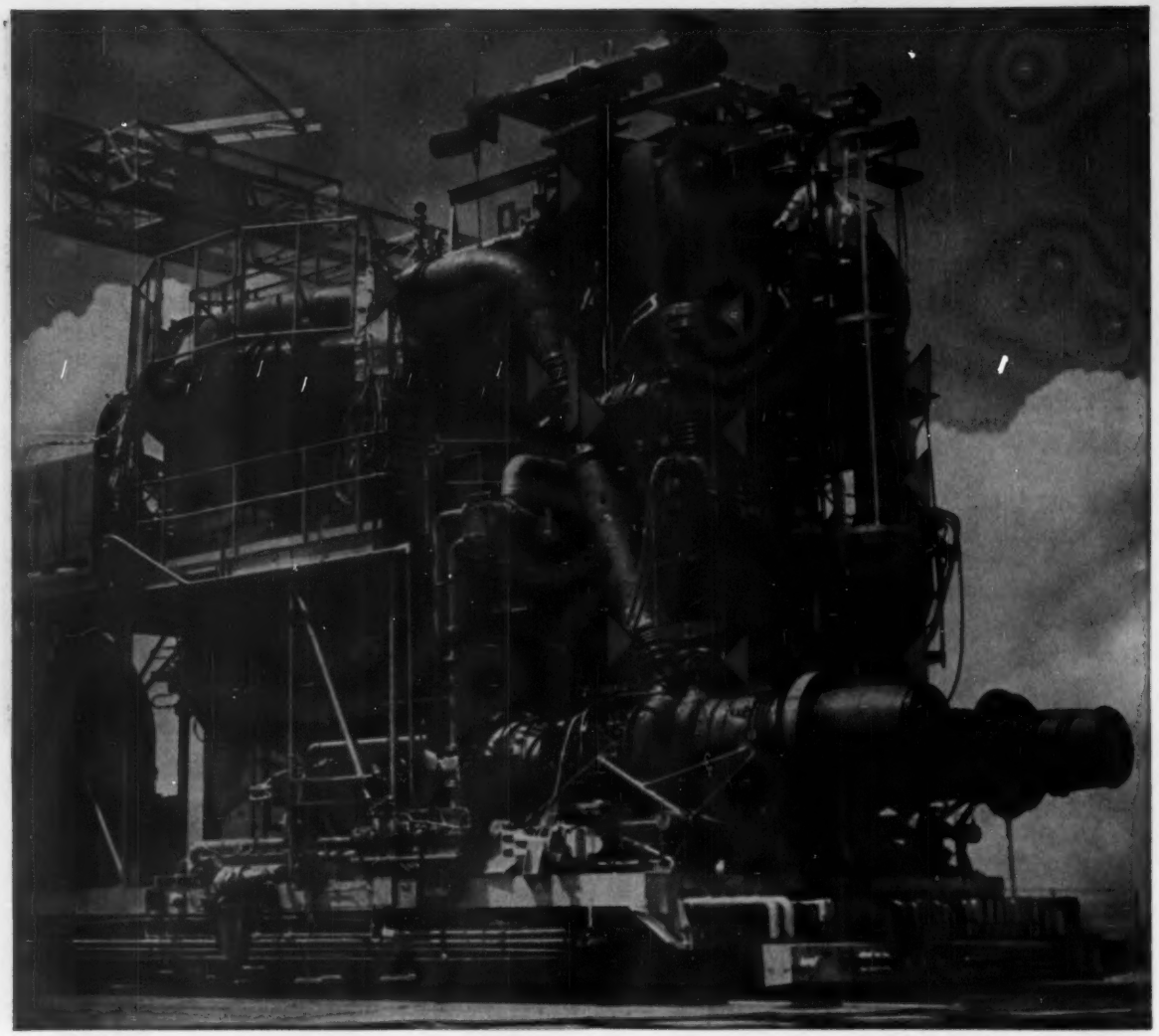
BECAUSE THEY'RE MADE BY CRANE, these new Flex Gates are completely dependable. You can use them with complete confidence on steam, water, gas, oil or oil vapor service. Stem and disc seating faces are Crane Exelloy. Shoulder-type body seat rings are Exelloy or Crane No. 49 Nickel Alloy. Sizes: 12 inch and smaller; 150- and 300-pound pressure classes.

Ask your Crane Distributor for full information on Flex Gates—and for data whenever you work with the products Crane makes. He has the newest in information and products. Crane Co., Industrial Products Group, 4100 South Kedzie Avenue, Chicago 32, Illinois.

CRANE®

VALVES • ELECTRONIC CONTROLS • PIPING • PLUMBING • HEATING • AIR CONDITIONING

For more facts circle 261 on Reader Service card, p 103



Where expansion joint reliability really counts... YOU FIND ZALLEA

Eighteen Zallea Expansion Joints protect all the piping between compressor, reactor and turbine in General Electric's Heat Transfer Reactor Experiment (HTRE). Sizes range from 18-in. to 30-in. diam. Temperatures are 500 F and 1500 F at 53 psig.

Objectives of HTRE were to develop and test a complete aircraft nuclear power plant system, to determine operating characteristics, and to verify the design of a direct-air-cycle nuclear propulsion system. As in any research involving unknown quantities (in this case the heat source) a basic requirement for all system components was *maximum reliability*. The results of HTRE were successful. Objectives were accomplished. The integrity and life of all system components were verified.

This is another example of Zallea competence in the nuclear field. In fact, Zallea has provided the large majority of all the expansion joints used in atomic, nuclear and missile projects. Our work with almost every major engineering and manufacturing firm in these fields has given us an unequalled background of experience and engineering capacity. It can give you important savings in time and investigation when expansion is involved in piping systems or tanks.

Write for Catalog 56, which contains complete and comprehensive engineering data for Expansion Joints from 3-in. to 50-ft. diam., pressures to 3600 psi, temperatures to 1600 F.

ZALLEA BROTHERS, Taylor and Locust Streets, Wilmington 99, Delaware.

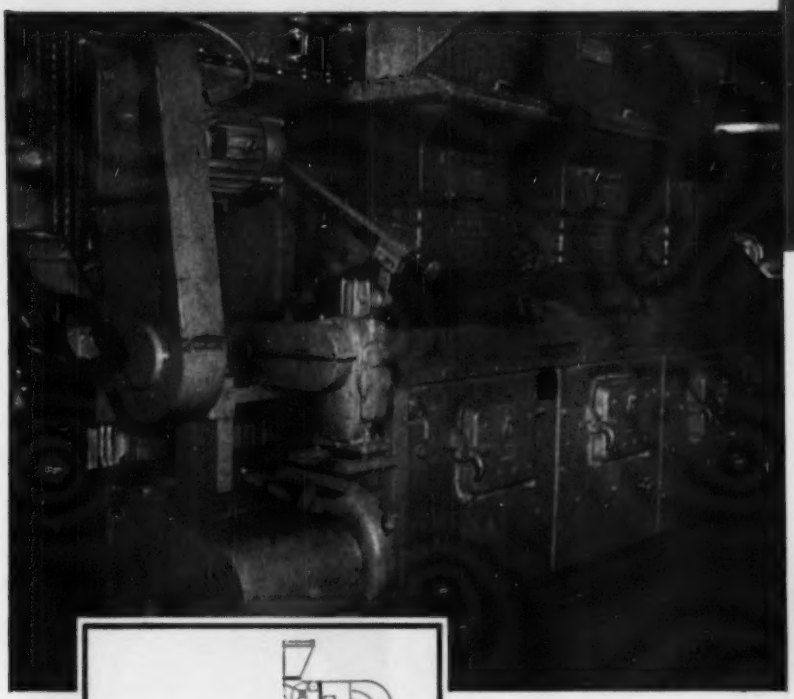
Zallea FOR MAXIMUM RELIABILITY

WORLD'S LARGEST MANUFACTURERS OF EXPANSION JOINTS

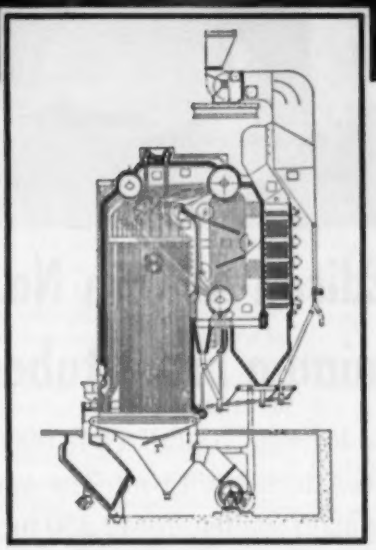
Availability?...

HERE'S A RECORD TO SHOOT AT..

....Only **5 HOURS OUTAGE in 5 years**



A Detroit RotoGrate Stoker



AT OTSEGO

Detroit RotoGrate Stoker with Wickes Boiler; 650 pounds pressure, 750°F temperature. Cummins & Barnard, Consulting Engineers.

This record of only 5 hours outage in over 5 years is reported by Otsego Falls Paper Mills, Otsego, Michigan, a division of Menasha Wooden Ware Corporation.

Walter Boettcher, Chief Power Engineer says: "*5 hours in 5 years and 4 months is the record of down time due to the RotoGrate Stoker outage*" in this well operated single boiler plant.

"*It operates 24 hours a day—5 to 6 days a week, 60,000 to 90,000 pounds of steam per hour.*

"*Paper mill load fluctuations handled easily without pressure loss.*"

This record indicates a fine job of equipment maintenance, but high availability can be taken for granted with the DETROIT ROTOGRATE.

A customer survey taken in all kinds of plants proves it.

DETROIT ROTOGRATE COSTS LESS

Cost = initial investment + upkeep + production losses due to outage of equipment. The total is less with RotoGrate.

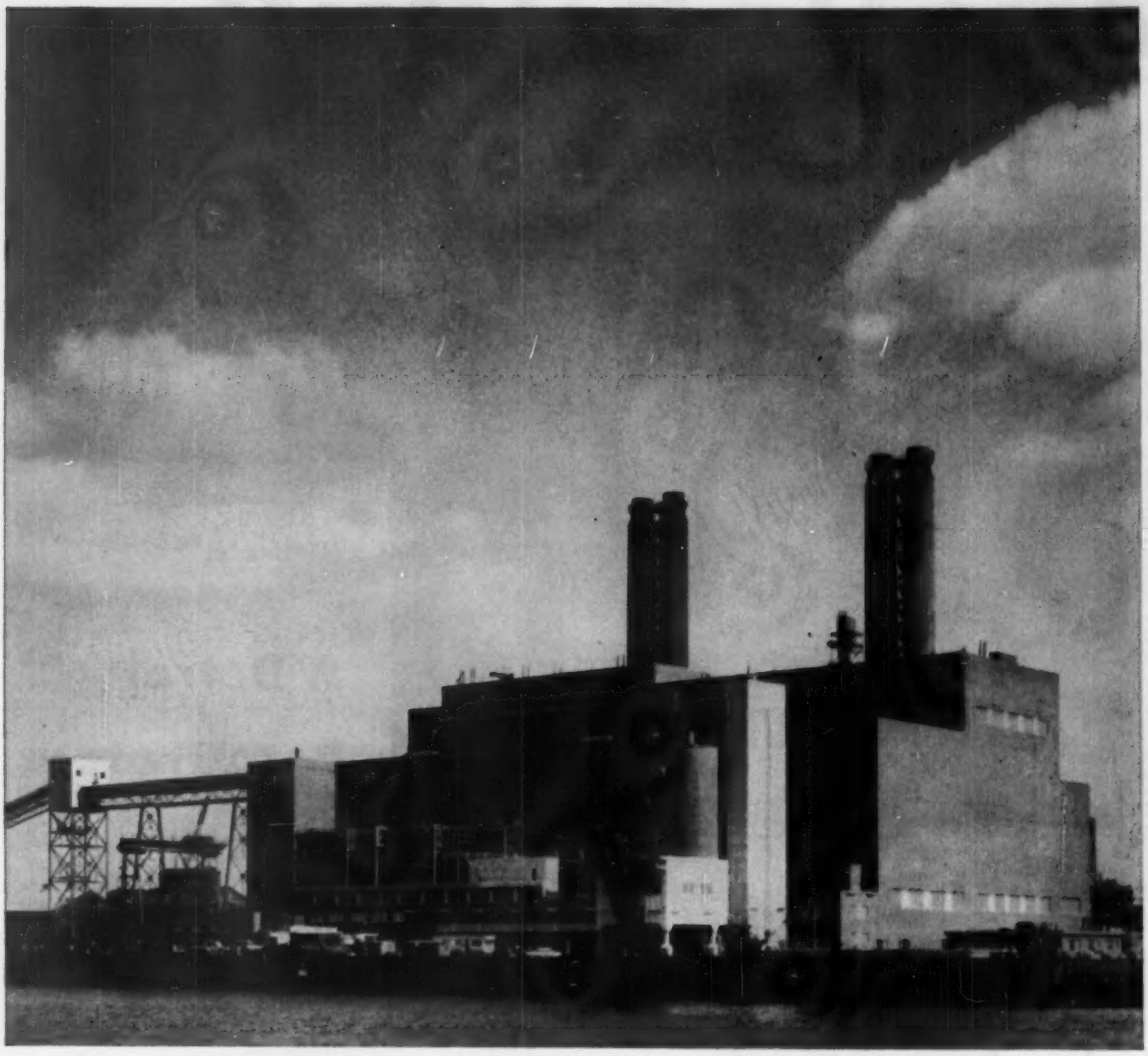
DETROIT STOKERS

DETROIT STOKER COMPANY

DIVISION OF UNITED INDUSTRIAL CORPORATION

Main Office and Works, Monroe, Michigan • District Offices or Representatives in Principal Cities

For more facts circle 263 on Reader Service card, p 103



Main condenser in Consolidated Edison Astoria No. 4 Unit will use Ambraloy-927 aluminum brass tubes

To meet New York's growing power needs, Consolidated Edison Co. adds a 340,000-kw block of generating capacity this year, when it starts up its Astoria No. 4 Unit. The American Brass Company is supplying half of the tubes for the main condenser—12,250 tubes, each 7/8" O.D. x .049" wall, of Ambraloy-927. This aluminum brass condenser tube alloy was developed by Anaconda to provide high corrosion resistance to clean and polluted sea water. It has established an excellent service record in steam power plants and oil refineries along the seacoasts—and in marine service on high-speed turbine-driven vessels. The American Brass Company, Waterbury 20, Connecticut. In Canada: Anaconda American Brass Ltd., New Toronto, Ontario. 8064

ANACONDA®

TUBES AND PLATES FOR CONDENSERS AND HEAT EXCHANGERS

Made by The American Brass Company

Hall Industrial Water Report

VOLUME 8 JULY 1960 NUMBER 4

You Don't Need a Crystal Ball

There are times when you wish that a look into a crystal ball would tell you what is happening in boiler tubes, turbines, water lines, heat exchangers and condensate systems. Are deposits forming? Is corrosion occurring?

Actually, you don't need the crystal ball. Simple water tests will usually tell you what is going on—whether water conditions are satisfactory for control of deposit formation and corrosion or whether changes should be made in chemical treatment to avoid trouble.

Interpretation of water analyses is everyday business to Hall Laboratories engineers. One of their functions is to teach operating personnel the test procedures and what the resulting numbers mean. And the Hall engineers can help you in many other ways to keep your plant operating with a minimum of water problems—in boilers as well as in cooling, process or waste disposal systems.

Water Not Responsible

Just when operation of a new boiler in a Canadian plant was well under way there was trouble. After six months' operation a side wall tube failed due to cracking. Then three months later another cracked.

Water conditions were blamed. The Hall engineer was called in. He was able to show that satisfactory water conditions had been maintained because the operators he had trained had conscientiously carried out the chemical feeding and testing program. Furthermore, metallographic examination of specimens from the cracked tubes showed that the problem was corrosion fatigue. This pointed to alternate overheating and quenching which could only result from discontinuous cooling by the water.

More water to the side wall tubes was provided by the installation of additional water supply tubes. Cracking stopped and the boilers have now operated more than three years without an unscheduled outage.

From Heat Pumps to Dishwashers

Diverse types of equipment including heat pumps, hot water boilers, steam boilers and cooling towers were utilized for heating and cooling in a county school system. Hall Laboratories was retained to tackle the numerous scale and corrosion problems. In addition to equipment, more than fifteen miles of piping were involved, some of it buried in concrete.

Hall field engineer H. V. Gedney made a thorough survey of water usage and equipment at each school. A water conditioning program was then initiated at each and responsible personnel attended a water treatment school conducted by Gedney.

Good results followed. After a year's operation corrosion was found to be greatly reduced. Scale problems had disappeared. But water always causes trouble—Gedney was asked next to solve the problem of corrosion and deposition in the dishwashing machines.

Hunting Iron

Heavy accumulation of iron oxide in boilers at a municipal power plant made necessary frequent cleaning of the boilers. Since tests showed that the iron was entering the boilers in the feedwater, Hall field engineer E. R. Lang recommended increasing pH value of condensate and feedwater by use of a neutralizing amine (Hagamin®). This would minimize corrosion in preboiler equipment and piping and thus reduce iron content of the water.

Reduction of iron concentration was not as great as expected. Further testing led to the discovery that the main source of iron was the zeolite-softened makeup water which came from the treated water storage tank. Iron concentration of this stored water was more than one hundred times greater than iron concentration of the softened water.

Makeup water is now supplied directly from the softeners. The stored water is used only in emergencies. Iron oxide accumulation in the boilers is no longer a problem.

Dancing Water

When suddenly faced with wildly fluctuating water levels and heavy carryover from the boilers, the operating men at a steel fabricating plant called in Hall field engineer M. E. Osmond. Quick action was necessary so Osmond temporarily quieted the boiler water with a Hagan antifoam. This gave time to hunt the cause of the unusual trouble.

Condensed steam samples collected for conductivity tests were found to contain oil. The first condensate collection tank checked was found to be loaded with oil. Further tracing led to a tank in which quenching oil was heated with a steam coil. The coil was leaking, admitting oil to the condensate.

Once the source of trouble was located, correction was easy. The condensate from the heating coil was diverted to the sewer until repairs could be made.

Water is your industry's most important raw material. Use it wisely.

How Consultants Solve Industrial Water Problems

There are no "stock answers" to industrial water problems. A new 24-page booklet, "Hall Laboratories —Industrial Water Consultants," describes the many ways industry can use water most economically. For a copy of this booklet, write on your letterhead to:

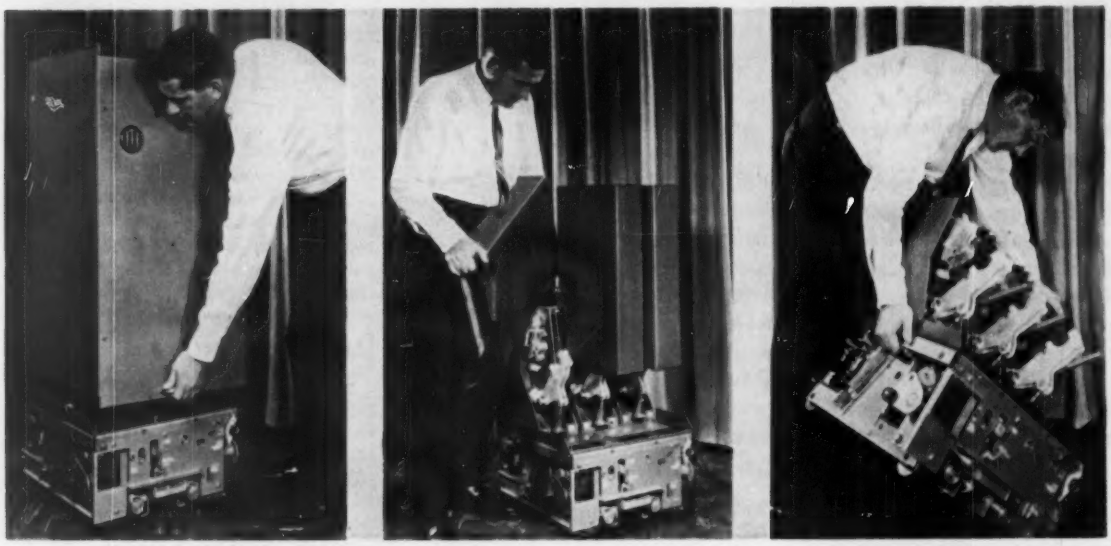
HALL LABORATORIES
HAGAN CENTER, PITTSBURGH 30, PA.
Consultants on Procurement, Treatment, Use and Disposal of Industrial Water

DIVISION OF **HAGAN** CHEMICALS & CONTROLS, INC.

For more facts circle 265 on Reader Service card, p 103

For more data on these developments, circle key numbers on Reader Service card, p 103

Plant equipment news... Your



ONE-MAN-MAINTENANCE feature of this new 4160-v equipment is demonstrated above. One man removes interphase barrier by lifting it from base of breaker, left. Arc chute is tilted and lifted from pivot point, center. He inspects all mechanisms, right

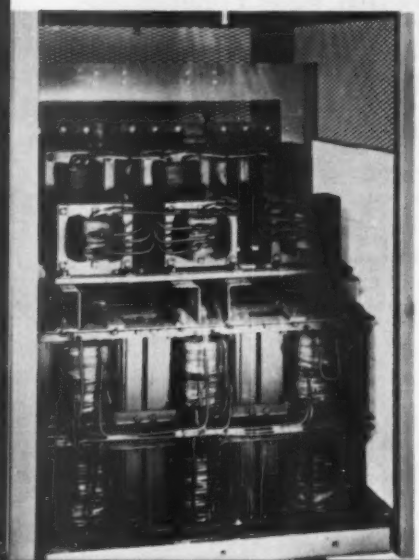
Breakers feature stored-energy closing, ironless blowout

1 • These 4160-v circuit breakers and switchgear give faster fault interruptions and close contacts faster than any comparable equipment in this range, maker claims. Completely redesigned units are smaller in size, too. Above, one man shows ease of handling during installation, maintenance and service. Besides compact size, equipment features low weight and low center of gravity.

Stored-energy closing is provided by a motor-charged spring-powered mechanism. Since there is no iron in magnetic blowout, arc chute weight is reduced for easier handling. One safety feature is the closed-door drawout. You can go from operating to test and disconnect positions while door remains closed for personnel safety.

Equipment's rigid construction — components are welded throughout, all frames are completely enclosed units with double barriers between them—will let it operate freely without trouble. All bus and wires have flame-resistant full-voltage insulation. Another feature: you can find out breaker's position with compartment doors closed. Transformers can be removed without disturbing bus; compartment doors, concealed-hinge pin types, can be removed with ease.—I-T-E Circuit Breaker Co

Static-magnetic voltage regulators handle large loads



2 • Units are designed for 3-phase circuits from 50 to 2000 kva. According to the manufacturer, they can serve very large machines or entire plant departments. Automatically and continuously, regulator delivers output voltage which is controlled within $\pm 1\%$ under line voltage variations as great as $\pm 10\%$. Response time is 1.5 cycles or less.

Unit is self-contained—transformer type device has no moving parts or complicated feedback systems. It has no tubes and requires no manual adjustments or routine maintenance. —Sola Electric Company

Encapsulated harness gives uniform, strong connections

3 • Connecting stator windings on large induction motors is made easy with two rings of insulated conductors encapsulated in epoxy resin. Bicycle-wheel-size ring with entrance-cable connections has short leads located at precise points for making series connections among the various coils. These connections do not have to be made by hand during motor assembly. Second harness, similarly constructed but slightly smaller, has connections for equalizing phase unbalances and suppressing harmonics. —General Electric Company

information center for new products and materials

Another electrical advance: solid-state equipment for remote indicating and control

4 • Supervisory equipment which releases valuable operating personnel from routine duties can be applied to any situation demanding remote metering, monitoring or control. System uses transistors, diodes and other solid-state elements in place of relays that have been used in the past. These devices act like mechanical switches.

Shown on right, hundreds of tie-pin-size transistors and diodes on transistorized cards direct and receive operation messages to and from remote apparatus through a master-station-remote-station hookup. Cards with no moving parts take an impulse originated by touching a button or an electronic connection and convert it into an outgoing code. Code is routed to a remote location, translated into an electrical impulse again and directs action.

Reverse occurs when action has been taken and a report is sent back telling what has happened. Each control has its own individual code made up of pulses and pauses; pauses carry operating intelligence.

Equipment is designed to operate on any 2-way communication channel, including low-cost telegraph-grade leased wire.—General Electric Company

POINT SELECTION on master station is first step in control of remote apparatus. Lamps represent actual equipment such as valves

PLUG-IN LOGIC CARDS have network of transistors, diodes, resistors and capacitors. This is control system's brain and heart

Dust collector ends hose-wear problems

5 • Unit answers need for volume fabric dust collection at low cost. It is adaptable to any application where dry materials must be reclaimed. Operation is simple: dust-laden air enters inlet plenum at top, then 9-in.-dia filter bags through venturi-shaped inlets. Air velocity holds very fine dust against inside of filter bags.

External-pressure blower connected to secondary air columns supplies reverse jet of air which dislodges fines. Columns in turn introduce h-p air to moving shoe which enters two rubber flaps mounted vertically in the open side of air column. This eliminates hose wear; guides up and down cleaning path of jet-case assembly. Constant pressure drop is maintained.—American Air Filter Co, Inc

Deep-pleat filter has high dirt-holding capacity

6 • Filter operates at lowest pressure drop, provides high efficiency and dirt-holding capacity, maker claims. Compact, folding-filter cartridges have deep-pleat design for larger media area, are interchangeable.

Series HP includes three atmospheric efficiency ranges—85, 95 and 35%. They are designed for any industrial ventilating or air-conditioning systems requiring high-efficiency air filtration with low maintenance costs. Folding media consists of reinforced material of fine glass fibers for high-range units and nonwoven cotton fabric for the lower-range unit. Manufacturer says that features include ease of installation and disposal in servicing flat or V banks.—Farr Company

Hydro-volute scrubber boasts high efficiency, wide range

7 • Anyone concerned with a dust, fume or odor problem will be interested in this scrubber, maker says. Scrubber which vortexes gas flow in a series of chambers has shown efficiency up to 99% on materials as fine as flyash. Swirling action within each chamber scrubs gas with water, wets dust particles and centrifuges them out of gas stream.

Unit is compact (smallest model is size of an office file cabinet) but its dust-handling ability can be as high as 15 to 20 grains per cu ft on dust loadings. Units have no moving parts or electrical wiring. They range from 1000 to 60,000 cfm. Effluent-gas temperature or moisture will not hamper efficiency. Liquid-level control is included.—Johnson-March Corp

For more data on these developments, circle key numbers on Reader Service card, p 103

More **equipment news**

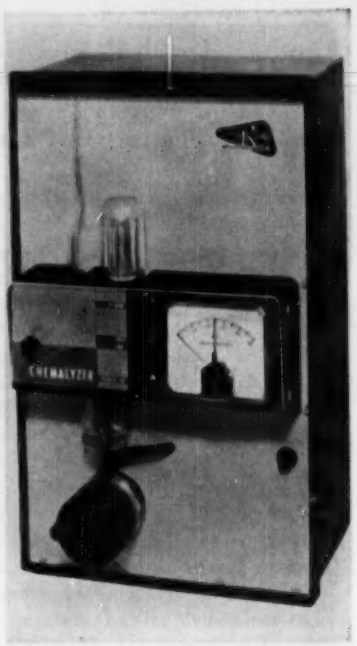
For more data on these developments, circle key numbers on Reader Service card, p 103

ANALYZER used in condensate-scavenging installations measures, on routine basis, parts per billion purity in condensate. Operator, left, adjusts volume measuring tank

Analyzer detects trace solids in feedwater

8 • Automatic instrument monitors insoluble solids but can be modified for solubles, has potential for measuring radioactive fluids. Millipore Filter test method is basis: particles extracted from sample by ultrafine-filter membrane leave circular stain on tape for identifying, sizing and counting. You can calibrate discoloration by analyzing a portion of sample and then running another portion through tape analyzer.

Millipore tape has effective porosity of 450 millimicrons; it can show concentrations as low as 2 to 4 parts per billion. As troubleshooter, analyzer pinpoints exact location of solids pickup. You can further test and analyze tape's stain by spectrophotometry, mass spectrography, flame photometry, chemical spot testing.—Graver Water Conditioning Company



Meter analyzes hardness with photoelectric comparator

9 • Chemalyzer does on-stream monitoring of hardness, residual chlorine or phosphates through photoelectric-comparison process in colorimetric analysis. Standard range of accuracy: hardness, 0 to 3 ppm; residual chlorine, 0 to 1 ppm; residual phosphates, 0 to 30 ppm. Indexing motor proportions 0- to 7-cc reagent feed with fixed sample volume at variable intervals.—Milton Roy Co

Butterfly valve shuts off drop-tight

10 • Resilient-seated butterfly valve gives positive drop-tight shutoff, is corrosion resistant, says maker. Much smaller in overall dimensions and weighing but a fraction of a gate valve, butterfly unit saves space, weight, cost.

Streamline-shaped disk opens full and returns to closed position in quarter of a revolution—no mating metal surfaces to corrode or bind. Resilient seat liner (abrasion-resistant rubber) snaps into body, covering interior, and also forms gaskets for mating flange surfaces. Shear pin which connects lever to shaft fails if valve is obstructed and left inoperable.—W S Rockwell Company

Turn a dial—working pump reverses flow

11 • Variable-capacity rotary pump lets you dial any desired flow rate from zero to full capacity without changing pump speed, according to manufacturer. Standard-speed motor powers pump, eliminating use of expensive variable-speed drive. Additional bypass piping and valves for evacuation of discharge lines are not needed because pump will reverse flow while in operation.

Applications include filling storage tanks and drums—using same pump. You can also use pump for viscosity and liquid proportioning. Sizes are 2 to 4 in. Capacity is up to 450 gpm.—Blackmer Pump Company

For more data on these developments, circle key numbers on Reader Service card, p 103

THE NEW, TIGHT-CLOSING PRESSURE REDUCING VALVE THAT *CAN'T FOUL*

If you like a simple, straight-forward solution to vexing valve problems, you're bound to be impressed with the new line of Leslie-Topper Pressure Reducing Valves. To avoid valve fouling, Leslie Engineers developed a tight-closing valve with an internal pilot that's completely out of the path of steam—*it just can't foul.* Let imaginative engineering simplify valve design and you get results.

Here's the one pressure reducing valve that handles poor steam conditions, intermittent or standby service better than any other valve. It provides high accuracy of regulation with negligible dead-end build up and costs only pennies for maintenance.

New, patented Leslie-Spiroflex* all metal diaphragm insures years of outstanding valve performance. It makes a long valve stroke possible in a packless design—there's nothing to leak, nothing to bind. It's time for a change when you can get rid of the cost and bother of fussy, old-fashioned pressure regulators.

*Trademark of Leslie Co.

Leslie-Topper Selection Table

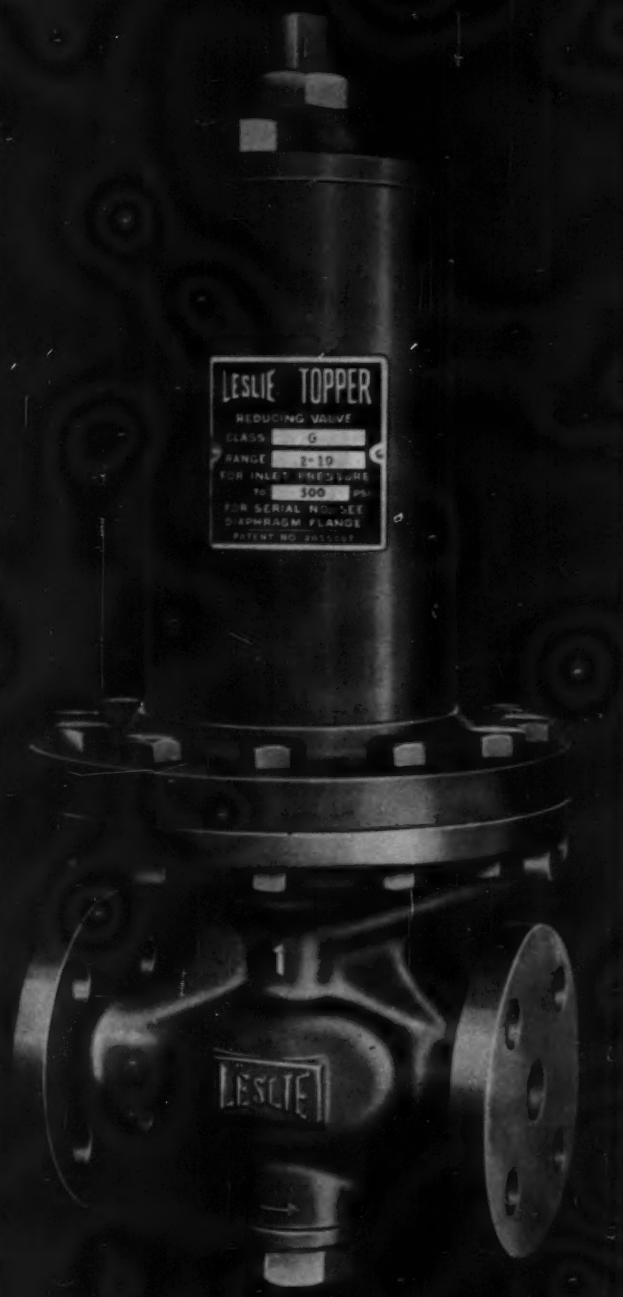
Size	Inlet Pressure PSI	Adjustable Pressure Range PSI	CLASS		
			Cast Iron Construction	Bronze Body Construction With Iron Superstructure Castings*	All Bronze Construction
½" TO 1¼"	UP TO 150	2 - 10	GKLL	GLL	GBLL
	OVER 125	2 - 10	GKL	GL	GBL
	UP TO MAXIMUM BODY RATING	5 - 20	GKM	GM	GBM
		15 - 35	GKH	GH	GBH
1½" TO 2"		2 - 10	GKL	GL	GBL
		5 - 20	GKM	GM	GBM
	UP TO 150	5 - 35	GKHL	GHL	GBHL

*All parts in contact with controlled fluid are of bronze.

For sizing and capacity data write for Bulletin 582 or contact your Leslie Engineer—he's listed in the Yellow Pages under 'Valves' or 'Regulators'.

Leslie Co., 701B Grant Ave., Lyndhurst, New Jersey

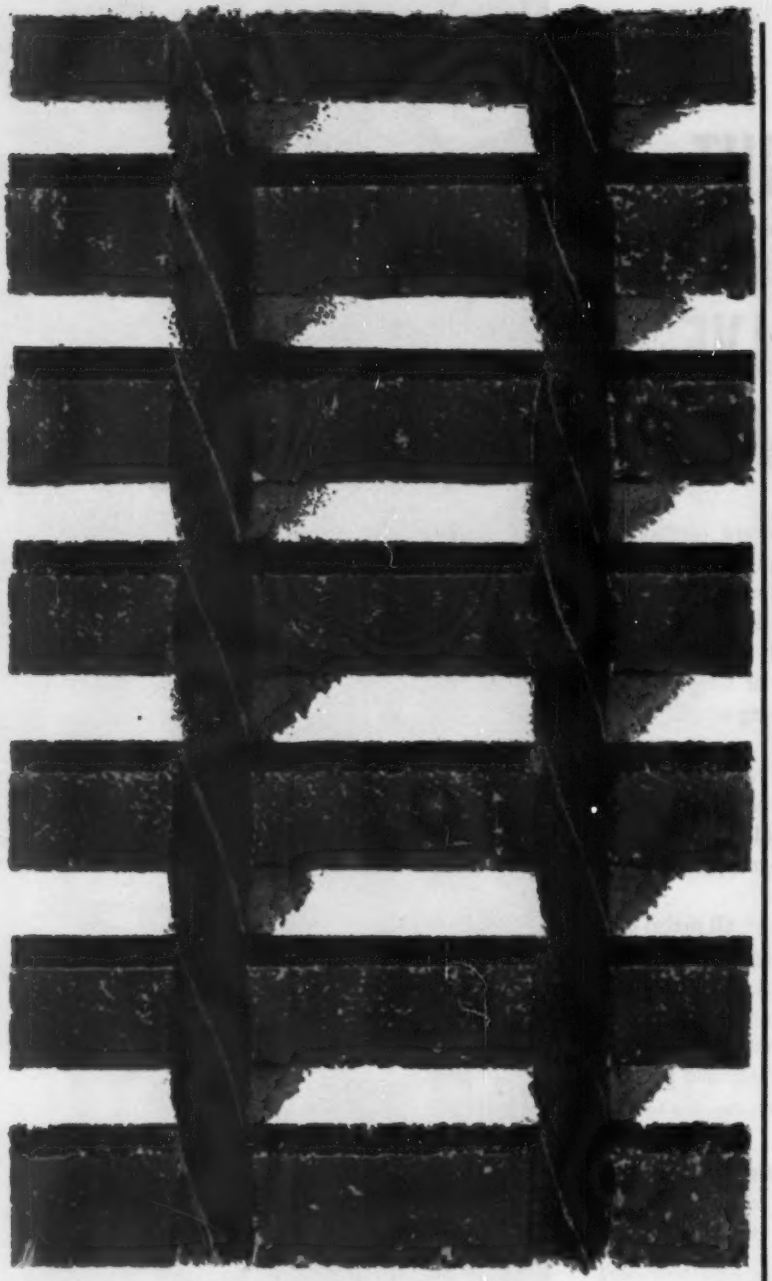
circle 266 on Reader Service card, p 103



This new Leslie Topper Pressure Reducing valve is a part of Leslie's expanding line of control valves, regulators and pilots for steam, air and liquids.

TRADE LESLIE MARK

REGULATORS and CONTROLLERS



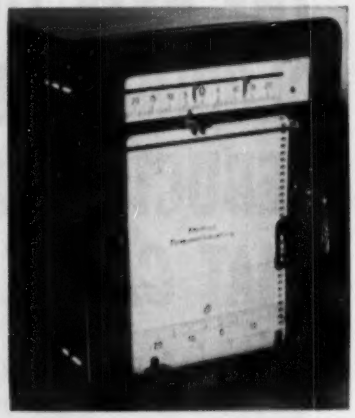
Blaw-Knox Electroforged Grating solves so many problems for so many industries. Catalog free on request. Write

Blaw-Knox Equipment Division, Pittsburgh 38, Pennsylvania.

BLAW-KNOX
GRATING

Equipment news

Begins on page 118

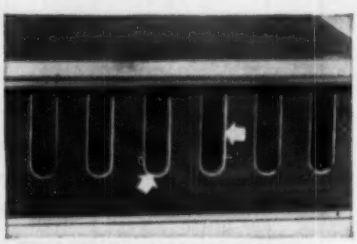


Recorders feature transistorized limit contacts

76 • Recorders allow installation of warning signals or control of processes without duplicating instruments. They can be equipped with either one or two set points for maximum-minimum control. There's no interference with writing pen since on-off contacts are inductively coupled to transistorized control circuit by vane attached to pen arm.

You can fix maximum set point in any position over range of 30 to 100% of full scale, and minimum set point between 0 and 70% of full scale. Accuracy of control varies between 0.5% at center of scale and 3% at end of scale.—Curtiss-Wright Corp, Princeton Div

Just circle key numbers on the Reader Service card, page 103, to get complete product story



Round-edged plastic duct protects wire insulation

63 • Electrical-wiring duct has rounded edges on wire slots to protect insulation on wires as they are

Facts you should have on file under "stokers"... and "savings"

(File this page, send coupon now)

Whether your company will talk new stoker next month or three years from now, your review of stoker performance will not be complete without the facts on AE Vibra-Grate Stokers and the outstanding savings assured with the exclusive Vibra-Grate design.

The AE Vibra-Grate Stoker is the only stoker which combines the maintenance-savings features of water cooling and the high-efficiency features of a vibrating grate and controlled zone undergrate air.

Operating reports from some of the country's most cost-conscious companies now using Vibra-Grate Stokers are nothing short of phenomenal.

For example: A 40,000 lb boiler fired by a Vibra-Grate Stoker at S. C. Johnson & Son (makers of Johnson Wax Products) has never had an unscheduled shutdown since the stoker was installed in October 1954. Coal savings have averaged 919 tons per year. There has been no trouble with clinkers or coking coals. Total repair costs for the first five years, when 34,962 tons of coal were consumed, were only $188. A hair over ½ cent per ton of coal!

For example: At Spaulding Fibre Company, two Vibra-Grate Stokers have saved 2000 tons of coal in two years, compared with other stokers in the same plant. Average evaporation on one unit is 10.6 lb of steam, 10.8 on the other, using coals having an average Btu value of 13,173. The company writes, "... efficiency and operating economies far in excess of the manufacturer's guarantee and our highest expectations".

For example: Savings of $300 a day are reported by a major textile manufacturer. In this instance oil fired boilers were replaced by a 70,000 lb/hr Vibra-Grate Stoker. The unit is operating at 80.7% efficiency, even though the boiler has no heat recovery equipment.

For example: An old 40,000 lb/hr boiler was restokered with a Vibra-Grate for Edgewood Division, Pilgrim State Hospital, Brentwood, Long Island. Savings are averaging 8 tons of coal per day.

Highest efficiencies anywhere

Because the AE Vibra-Grate Stoker design is completely different you get a range and combination of advantages not possible with any other stoker.

The vibrating grate (A) insures compact distribution of fuel, and elimination of holes and light spots. Thus, the stoker can handle low or high volatile bituminous coal, as well as lignite and semi-anthracites—wet or dry.

Water-cooled grate (B) permits use of gas or oil fuels, singly or in combination with coal. Clinkering and coking are minimized, grate maintenance is virtually nil.

Individual control of combustion air in separate wind box zones (C), plus over-fire air system, eliminates smoke at both high and low steaming rates. There is no need for a dust collector. Ashes can be removed by conventional systems.

The complete Vibra-Grate story is covered in our new catalog S-546-A. Send for your free copy now, so all the Vibra-Grate facts will be available when you need them.

AMERICAN ENGINEERING COMPANY Division of United Industrial Corporation
Wheatsheaf Lane & Sepviva St., Philadelphia 37, Pa.

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☐ We would like to discuss our stoker needs. Please have a representative call. We understand there will be no obligation.

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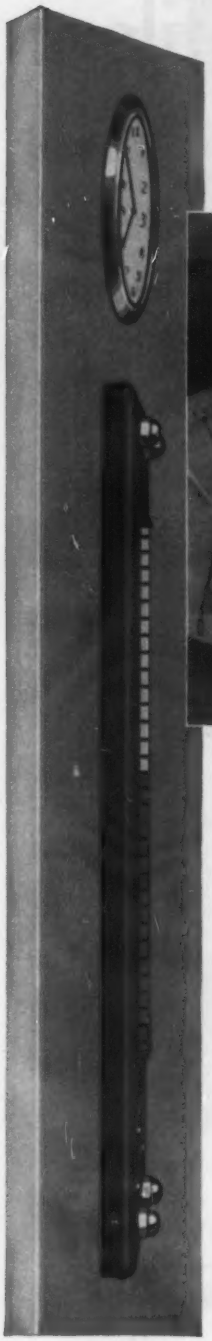
City_____ Zone_____ State_____

For more facts circle 268 on Reader Service card, p 103

Reliance EYE-HYE®



the first successful

remote reading water level gage

known to American engineers

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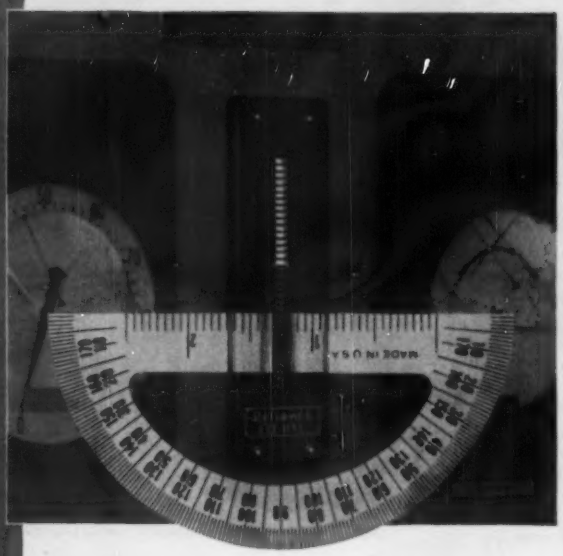


All-liquid operation—simple manometric principle.

Liquid column reading—like the familiar boiler gage.

Sharp *bi-color* indication—water level in drum indicated by a bright green column; steam space indicated by plain water.

Generous reading range—latest model EYE-HYEs are clearly read all around your control room.

Never quits through power failure; only the illumination fails, but gage still functions perfectly—can be read by daylight, flashlight or temporary room illumination.

Never a "sissy"—EYE-HYE has no delicate parts to get out of adjustment. Construction is rugged.

Boiler room personnel can't tamper—each EYE-HYE is calibrated at factory for its specific job. No adjustment needed at job site—*can't* be improperly adjusted on location.

Maintenance almost nil—EYE-HYE simplicity makes few demands for service.

EYE-HYEs are now serving well satisfied users throughout the world, on land and sea. Models for wall or panel mounting; pressures to 3000 psi. Write for EYE-HYE catalog material.

The Reliance Gauge Column Co., 5902 Carnegie Ave., Cleveland 3, Ohio

Reliance BOILER SAFETY DEVICES

Equipment news

Begins on page 118

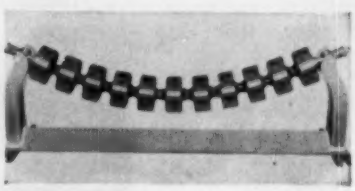
pulled through slots. Edges are especially helpful when wires are installed. They also protect insulation from subsequent chafing, cutting and abrasion from physical contact with sharp duct edges.

Duct is made of nonflammable plastic, includes a snap cover, is easily cut and installed. — Panduit Corp

Compressed-air dryer features large capacity

62 • Air dryers have capacities of 10,000, 11,000 and 11,500 cfm at 100 psi. Unit will dry any volume of compressed air—from total air for entire plant to minimal air for small operations. Adaptable to any air system, dryers are automatic, require no regeneration, heat or power. Drying process intercepts residual water vapor, microscopic abrasives and potent acid fumes which elude aftercooler, receiver and filters. — Van Products Co

Just circle key numbers on the Reader Service card, page 103, to get complete product story



Catenary conveyor carrier

74 • Conveyor carrier is said to provide true catenary suspension for conveyor belt under all load condi-

For more facts circle 269 on Reader Service card, p 103

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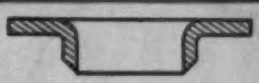
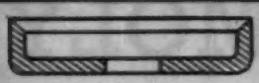
PRECISELY DIMENSIONED* U's, CUPS, FLANGES





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Why not try these high quality Anchor products now, and gain the advantages of a packing engineered for your specific application. And, whenever you have a packing problem, consult your local Anchor Representative; he is an expert, and he will gladly help you. You can have information on the many Anchor products just by writing for our catalog.

*Write for detailed circular listing sizes.

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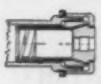
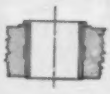
No galling or seizing. Specified torque produces uniform tension.



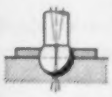
COLLET CHUCKS
Trouble-free opening and closing. No sticking.

SPLINED SHAFTS & HEAVILY LOADED GEARS
Reduces fretting and wear. Also used for wearing in heavily loaded gears.



PRESS FITTING
Prevents galling, seizing, metal pick-up and distortion.

METAL FORMING
Makes difficult jobs easy and increases die life. Effective on punching and stamping tools.



SPHERICAL SEATS
Effective on spherical seats, rod end bearings, universal joints or wherever reciprocating motion exists.

POWER SCREWS
No galling or seizing.

Send for your FREE SAMPLE of MOLYKOTE G LUBRICANT today. We will also send a copy of our new Bulletin 126B-1 with complete details.

THE ALPHA-MOLYKOTE CORP.
65 Harvard Ave., Stamford, Conn.
Please send me a free sample of your MOLYKOTE G Lubricant.

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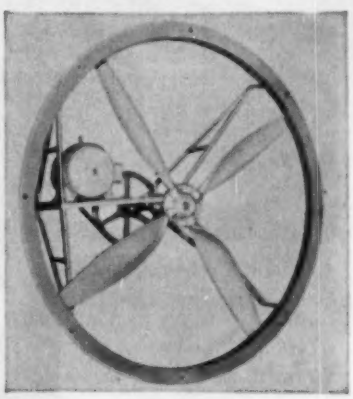
MOLYKOTE G *Lubricant*
Industry's Newest Production Tool

tions. It features high-tensile spring-steel dead shaft which mounts mild-steel trunnion and shock-absorbing compression spring. Carrier supports belt in natural arc, efficiently training belt and reducing wear.

Carrier rollers resist corrosive, abrasive, greasy, oily and combustible materials, says manufacturer. Natural flexing action should reduce material breakage, spillage and build-up. All-steel jig-welded frame is self-cleaning. — Stephens-Adamson Mfg Company, Standard Products Div



Low-speed high-volume fans

66 • Propeller type fan replaces using several smaller units in moving large volumes of air, increasing efficiency and economy, says maker. Unit has 65- to 94-in. belt-drive, direct-drive or pulley-drive construction. The 94-in. 25-hp model moves 174,000-cfm free air. Hubs and blades are aluminum alloy castings. —Hartzell Propeller Fan Co

Just circle key numbers on the Reader Service card, page 103, to get complete product story

Support bar cradles 55-gal drums for easy moving

92 • Drum-support bar holds 55-gal drums for easier movement and placement by fork-lift trucks. Safety support beam has welded stops at top of flange. You can incorporate support beam in adjustable storage rack and attach it to upright frames quickly

16,000 engineers can't be wrong!

Over the last 50 years, engineers of more than 16,000 steam plants have specified and used Yarway Seatless Blow-Off Valves.

Why?

They know that . .

Savings in maintenance costs . . .
Freedom from boiler outages . . .

have repaid over and over again the cost of Yarways!

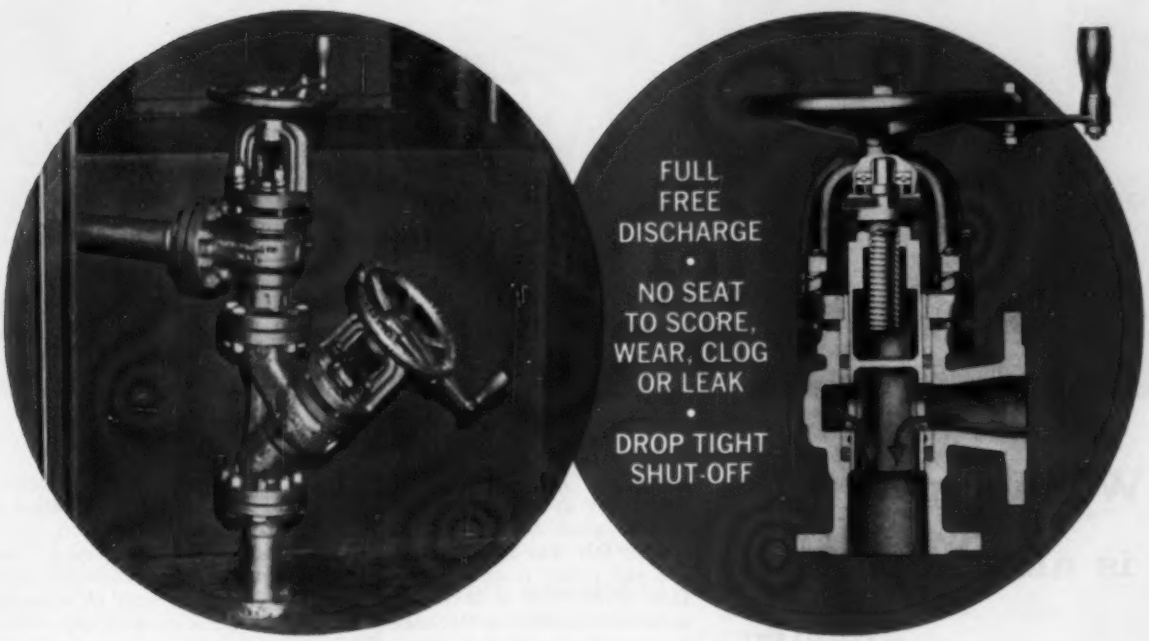
How?

Exclusive Yarway "Seatless" valve design means . . . NO SEAT TO SCORE, WEAR, CLOG OR LEAK!

If you are planning purchase of a new boiler, or modernization of present boilers, *insist on protecting your investment with Yarway blow-off valves.*

Write for Yarway Bulletin B-427.

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES



Typical installation of Yarway Seatless Blow-Off Valves

A FEW OF MANY BOILER MANUFACTURERS STANDARDIZING ON QUALITY YARWAY BLOW-OFF VALVES

BROS INCORPORATED
CLEAVER-BROOKS CO.
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ERIE CITY IRON WORKS
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STRUTHERS-WELLS CORP.
THE TITUSVILLE IRON WORKS CO.
HENRY VOGT MACHINE CO., INC.
THE WICKES CORPORATION

YARWAY
A MARK OF QUALITY IN STEAM ENGINEERING

For more facts circle 272 on Reader Service card, p 103

Old Security Life Insurance Bldg., Insul. Contractor: Central Insulation, K. C., Mo.

When appearance is also important . . . specify G-B SNAP*ON®

FOR AN ATTRACTIVE, FINISHED PIPE INSULATION JOB, SPECIFY G-B SNAP*ON—the original one-piece pipe insulation molded of fine glass fibers. On the job shown above, canvas-covered G-B SNAP*ON was applied and then painted. As you can see for yourself, the end result is an immaculate-looking network of insulated pipe. And G-B SNAP*ON is as thermally efficient as it is neat in appearance—usually requires less thickness than other general purpose pipe insulations to provide specified thermal efficiency.

In addition, G-B SNAP*ON is economical, because it can be easily and quickly snapped over pipe in one effortless motion. Because it is made entirely of glass fiber, G-B SNAP*ON is less susceptible to damage, easier to handle—and there's less waste! G-B SNAP*ON is available in 3′ (as used in the job above) and 6′ sections for cold and hot lines up to 350°, indoors or out—plain or with a variety of factory-applied facings.

FOR INFORMATION AND DELIVERY
CALL YOUR LOCAL G-B SNAP*ON DISTRIBUTOR
(LISTED IN ADJOINING COLUMN)

GUSTIN-BACON *Manufacturing Co*

242 W. 10th Street, Kansas City, Missouri

Thermal and acoustical glass fiber insulations . . . Molded glass fiber pipe insulation
Couplings and fittings for plain and grooved end pipe

G-B SNAP*ON DISTRIBUTORS

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ALBANY, Ga., Industry Insulation Co.
ALBANY, N. Y., Hudson Valley Asbestos Corp.
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AMARILLO, Tex., McDonald Engineering & Insulating Co.
ATLANTA, Ga., Reynolds Aluminum Supply Co.
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BANGOR, Me., Eastern Glass Co.
BATON ROUGE, La., Eagle Asbestos & Pkg. Co.
BEAUMONT, Tex., Solar Supply Co.
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CLEVELAND, Ohio, Ohio Asbestos & Insulation Co.
COLUMBIA, S. C., Industrial Insulation Div. of Richland Oil Co.
COLUMBUS, Ohio, Santeler Brothers
Culberg of Ohio
CORPUS CHRISTI, Tex., Precision Insulation Co.
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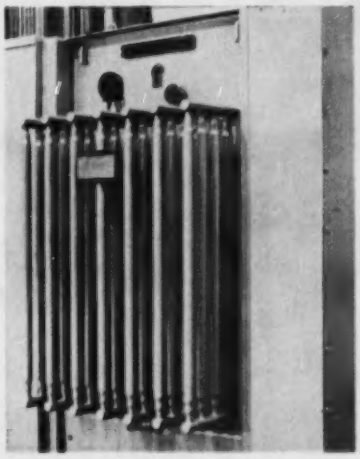
WASHINGTON, D. C., Walter E. Campbell Co., Inc.
WEST PALM BEACH, Fla., Southern Metal Prod.
WICHITA, Kans., General Metals, Inc.

SO 5-15-60

Equipment news

Begins on page 118

and easily with a floating wedge lock. It can be used for bulk or drum storage.—Union Asbestos & Rubber Co, Sturdi-Bilt Material Handling Div



Redesigned distribution-equipment transformers

83 • Conventional units with 300- to 2500-kva rating and stacker type units with rating of 112½ to 225 kva are for use as integral distribution-center or substation load-center transformers. According to maker, their purpose is to step down plant distribution voltage to utilization voltages.

Units are said to be lighter than previous models, mechanically stronger and rugged. External design features welded flanges to eliminate rust and corrosion-prone openings. — General Electric Co

Just circle key numbers on the Reader Service card, page 103, to get complete product story

Pressure transducer permits easy stacking

68 • Subminiature pressure transducer with range of 0-5 to 0-5000 psia, 7-v dc or ac excitation, provides 42- to 56-mv nominal output. Series includes absolute gage and bi- and unidirectional differential-pressure transducers. Compensated temperature range is −65 to 250 F, ambient temperature limits −100 to 275 F. —Statham Instruments, Inc

MERCOID®

WEATHER PROOF CONTROLS

For PRESSURE - TEMPERATURE

FOR OUTDOOR APPLICATIONS
NEMA 1A, 2, 3, 4

Available in various operating ranges with differentials to meet your requirements.

WRITE FOR BULLETIN 6-18

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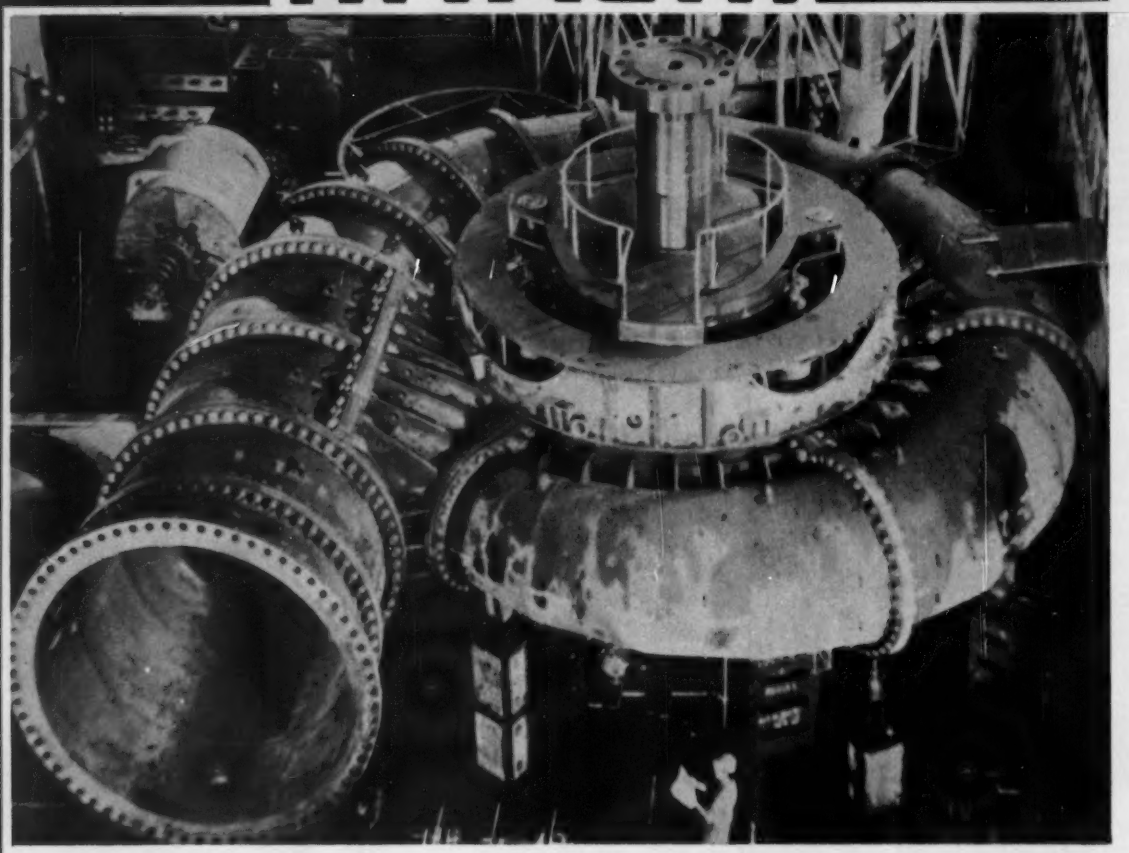
THE MERCOID CORPORATION
4201 BELMONT AVE., CHICAGO 41, ILL.

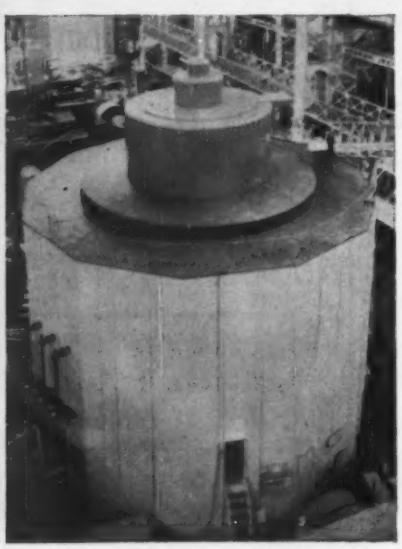
HITACHI



Another big Hydraulic Turbine and Generator by Hitachi

Hitachi has recently completed two 137,500kw/125,000kVA hydraulic turbines and generators for the Miboro Power Station in Central Japan.

The turbine is of the vertical-shaft Francis type, and specified for a speed of 225rpm, a maximum effective head of 200m and 76.6 cu.m/sec water flow, making it one of the largest units of its kind in the world. Its runner has a maximum diameter of 3.7m and the main shaft a diameter of 95cm. The spiral casing, which was constructed in 13 sections to facilitate transportation to the site, has an inlet diameter of 3.35m and an outer diameter of 11.2m.



The generator presents a high-torsoed appearance as shown in the photograph, having been so designed in consideration of the comparatively high speed. Since the generator was designed for a rated voltage of 16,500 volts and, in this respect, represents the first such attempt in Japan, particular care was taken in the corona-shielding and impulse resistance of the stator winding.

The generator is rated at 60 cycles, 225rpm and 0.9 power factor but is also capable of operating at 50 cycles, 187.5rpm and 1.0 power factor.

Hitachi, Ltd.
Tokyo Japan
Cable Address: "HITACHY" TOKYO

For more facts circle 275 on Reader Service card, p 103

FISHER "HH" 2500 lb. A.S.A. BODIES

for HIGH PRESSURE AND TEMPERATURE SERVICE

CALL YOUR *FISHER/MAN*

Guides and bushings are Stellite faced to prevent seizing or galling. Guide posts are made extra large. This extra protection means longer life.

CALL YOUR *FISHER/MAN*

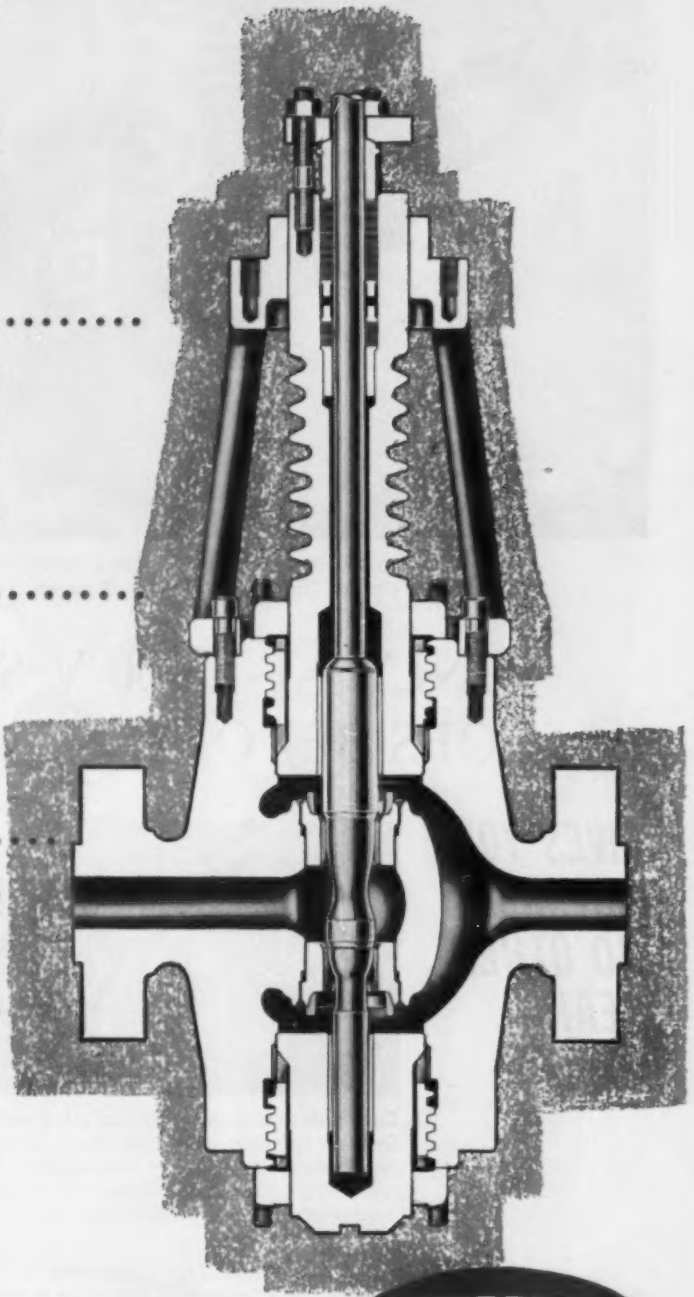
Screwed-in seat rings are Stellite faced to eliminate erosion and wire drawing. Fisher seal welds them in place to keep rings from working loose and to prevent leakage past the threads.

CALL YOUR *FISHER/MAN*

Available in single or double ported body designs—one and two inch sizes in the single ported and two, three and four inch sizes in the double ported design.

CALL YOUR *FISHER/MAN*

Use of a pressure sealed bonnet eliminates need for heavy, cumbersome flange heads. Head construction with or without cooling fins is available.



CALL YOUR *FISHER/MAN*
or write FISHER GOVERNOR COMPANY for complete information and literature.

IF IT FLOWS THROUGH PIPE ANYWHERE IN THE WORLD . . . CHANCES ARE IT'S CONTROLLED BY . . .

FISHER GOVERNOR COMPANY

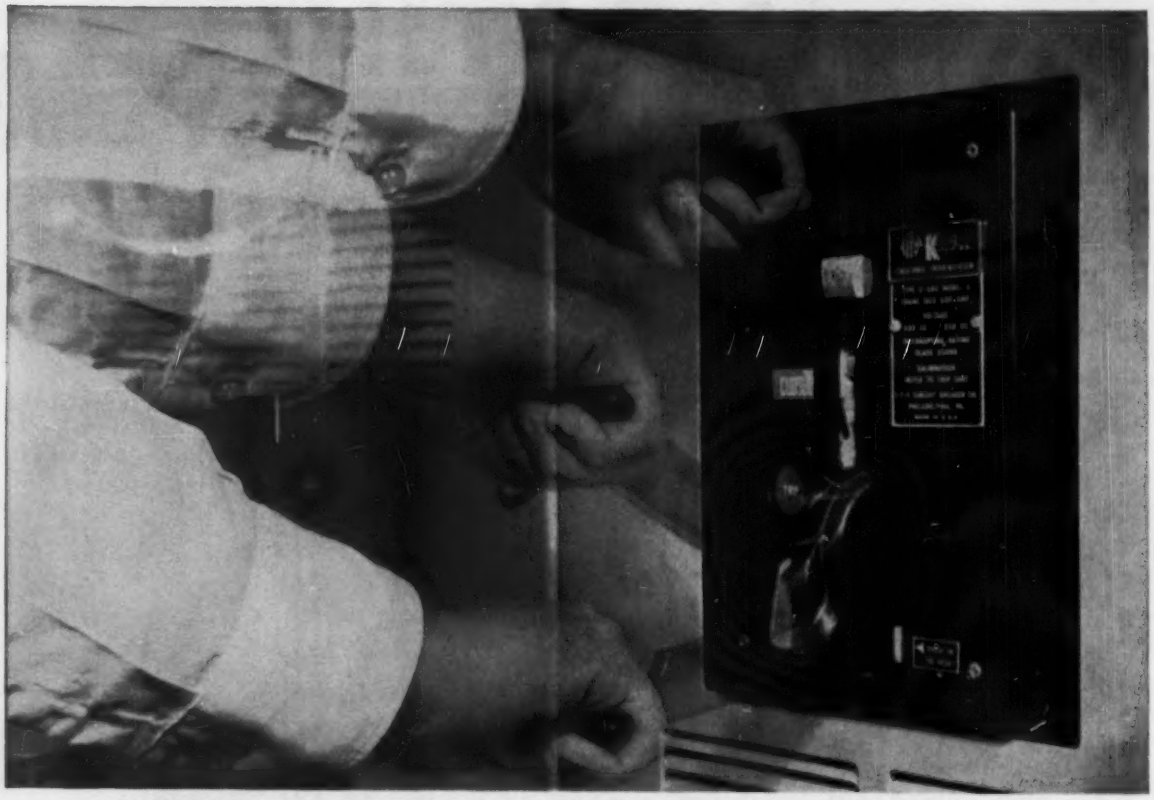
Coraopolis, Pennsylvania / Woodstock, Ontario / London, England

MAIN OFFICE AND PLANT — MARSHALLTOWN, IOWA

FISHER® Controls

SINCE 1880

For more facts circle 276 on Reader Service card, p 103



I-T-E started a revolution in 1957 when it introduced the completely new K-Line circuit breaker with stored energy closing. Today it is still the most advanced circuit breaker for low voltage switchgear you can buy.

ONLY I-T-E 600 V. SWITCHGEAR GOES BEYOND STORED ENERGY

GIVES YOU ADVANCES NO OTHER GEAR OFFERS

Closed door disconnect. A real safety feature. Operator can rack breaker out to either test or disconnect position without opening door. Prevents cluttered aisles from open doors and protruding breakers. And keeps breakers clean when they are disconnected.

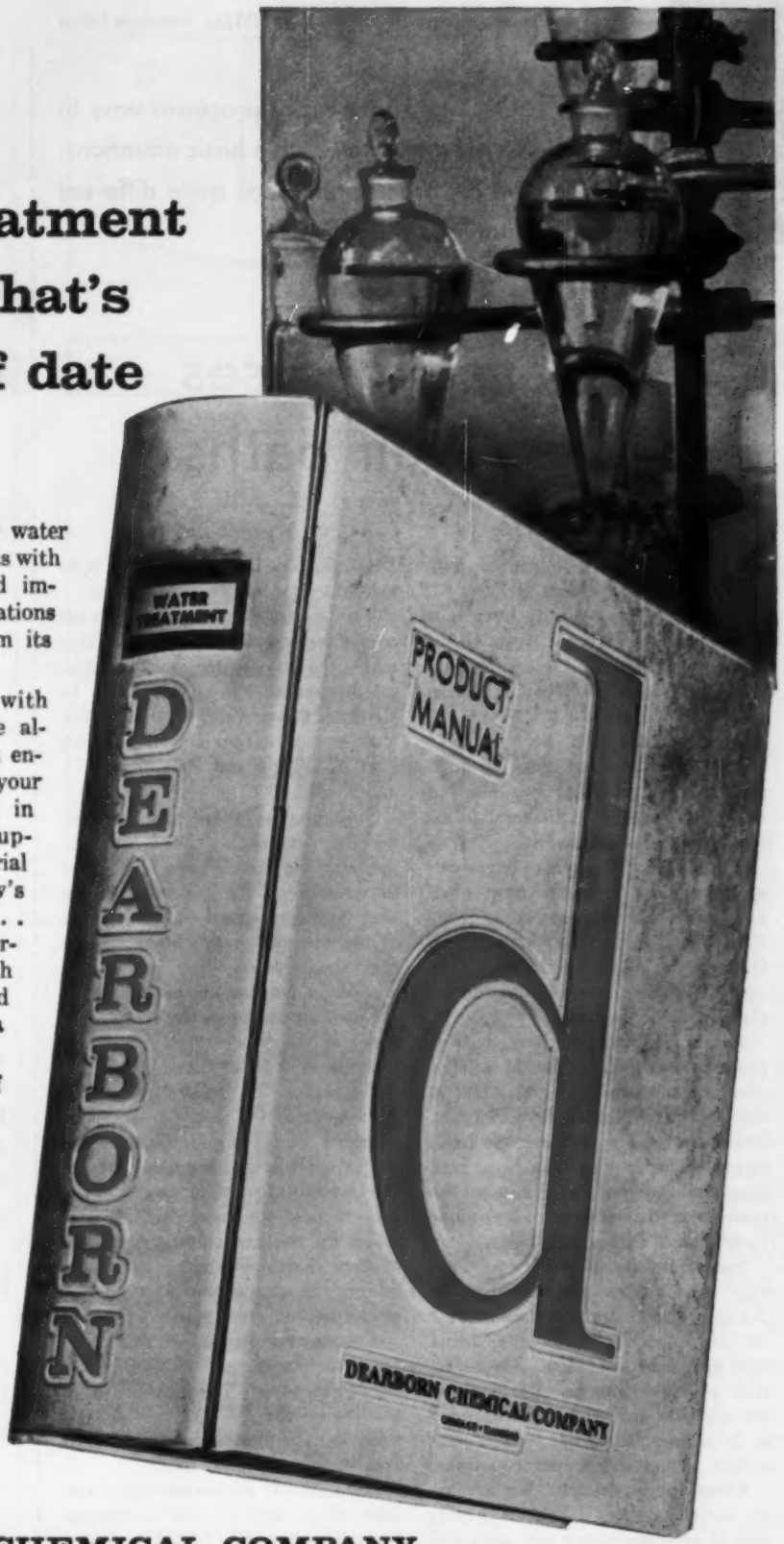
Expanded range trip. I-T-E breakers can grow with your loads. Each trip device has roughly three to four times the range of conventional devices. Saves cost and downtime that replacement would demand. Easy to adjust. Calibrated directly in amperes.

You pay no more. That's right. With all these extra advances I-T-E low voltage switchgear costs no more. Send for detailed descriptive Bulletin 6004-C. I-T-E Circuit Breaker Company, Dept. SW, 1900 Hamilton St., Philadelphia 30, Pa.

I-T-E CIRCUIT BREAKER COMPANY

For more facts circle 277 on Reader Service card, p 103

A water treatment MANUAL that's never out of date



Dearborn helps pre-solve your water treatment and corrosion problems with a continuous flow of new and improved products . . . new applications . . . new techniques . . . from its Technical Center in Chicago.

Bulletins covering these—with specific case history data—are always in the hands of Dearborn engineers for their application to your particular needs. Incorporated in loose leaf product-manuals—updated continuously—this material helps him give you tomorrow's answers to today's problems . . . to provide you with the thoroughness in service for which Dearborn has been recognized for nearly three quarters of a century.

You may obtain any part of the information in the manual from a Dearborn engineer . . . or by writing for technical data covering your particular water treatment or corrosion problem. Do it today.

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For more facts circle 278 on Reader Service card, p 103

THERMO REFRESHER NO. 40

By B G A SKROTZKI, Associate Editor

Steam Tables and charts make processes easy to figure. We need only the simple basic equations, but steam-chart process lines look quite different from familiar gas-chart lines

Steam processes trace their paths

Having acquainted ourselves with Steam Tables and charts in Parts 37, 38 and 39, we're ready to learn how to apply them. We use steam like a gas, as a working fluid to convert heat to work, or to produce high-speed fluid jets, or convert work to heat, or produce refrigeration, etc. We make water and its vapor pass through processes just the same as gases; but the water phase often changes, so the process behaves differently.

Processes. These three pages catalog six basic processes most often used to make up a steam cycle. They are all ideal in that they assume zero friction and radiation losses. They are reversible processes with the exception of the last two.

For each process we have the *P-V* graph at top, then the energy-balance diagram, next the *T-S* graph and at the bottom a Mollier or *H-S* chart. Below the charts we have the basic equations for each process. None have exponential quantities because all the complex mathematics have been done in the Steam Tables and charts.

Subscript *1* for W and Q means energy entering the process, subscript *2* means energy leaving. Subscript *1* on all properties means the initial state and *2* the final state. The reversible processes can be carried on in the opposite order; then all we need to do is interchange the *1* and *2* subscripts to get the proper equations.

Constant pressure. We assume the initial state *1* as wet steam (a mixture of saturated vapor and saturated water) in a cylinder and piston. Addition of Q raises the internal energy E and expands the steam making it do mechanical work W on the piston.

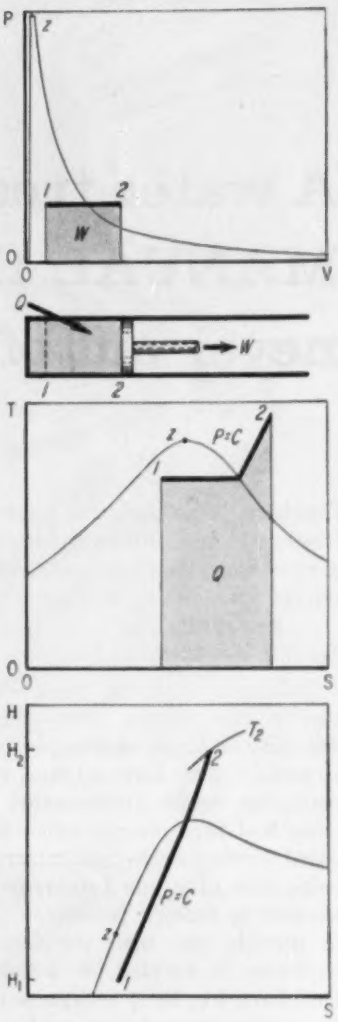
The process proceeds till steam becomes superheated at state *2*. This makes the process line cross the saturated-vapor locus in all the charts. In all three the process, of course, follows a constant-pressure locus, see Part 37, Fig. 4 and Part 38, Fig. 1 and 3.

Since process is reversible, area under the process on the *P-V* graph measures the work W and area under the process on the *T-S* graph measures heat transferred Q. End points of the process on the Mollier chart give the corresponding enthalpies; areas have no meaning on this chart.

Equation (1) gives the energy balance for the process; (2) and (6) give the work W as measured on the *P-V* graph. (3) relates the right-hand sides of (1) and (2) and substitutes $H = E + PV/J$. Clearing, we get (5). Once we have these properties in terms of enthalpy we can easily solve them by finding H's in the steam tables for the particular states. The Mollier chart gives H's directly by finding the intersection of P and T properties for given states.

Constant volume. In this process Q simply raises the internal energy of the steam. The vertical process line on the *P-V* graph shows no work can be done because of zero area under a vertical line.

Equation (3) relates the right-hand sides of (1) and (2) and substitutes from $H = E + PV/J$. (5) evaluates Q in terms of H, but (6) shows the basic simple relation in terms of E.



Constant pressure

Process: $P_1 = P_2 = constant$

Nonflow energy equation:

$$W_2 = E_1 - E_2 + Q_1 \quad (1)$$

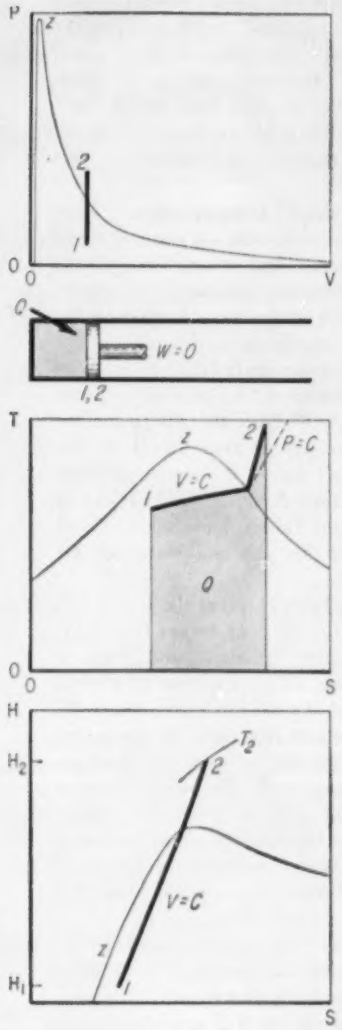
$$W_2 = \frac{P_2V_2}{J} - \frac{P_1V_1}{J} \quad (2)$$

$$\left(H_1 - \frac{P_1V_1}{J}\right) - \left(H_2 - \frac{P_2V_2}{J}\right) + Q_1 = \frac{P_2V_2}{J} - \frac{P_1V_1}{J} \quad (3)$$

$$H_1 - H_2 + Q_1 = 0 \quad (4)$$

$$Q_1 = H_2 - H_1 = W_2 + E_2 - E_1 \quad (5)$$

$$W_2 = \frac{P_1}{J}(V_2 - V_1) \quad (6)$$



Constant volume

Process: $V_1 = V_2 = constant$

Nonflow energy equation:

$$W_2 = E_1 - E_2 + Q_1 \quad (1)$$

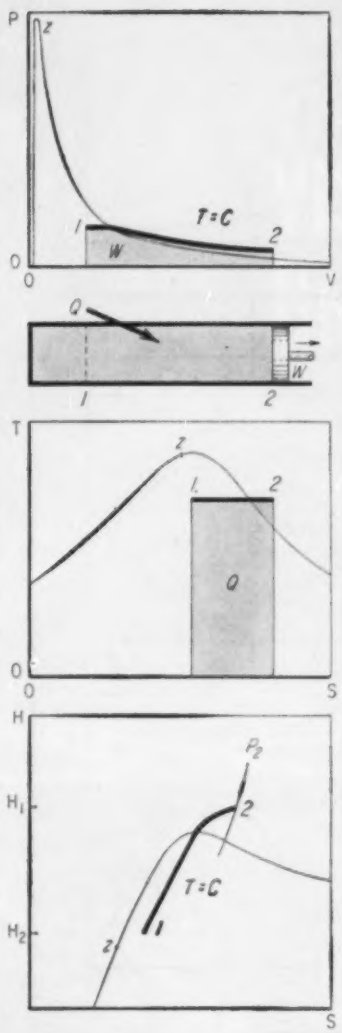
$$W_2 = 0 \quad (2)$$

$$\left(H_1 - \frac{P_1V_1}{J}\right) - \left(H_2 - \frac{P_2V_2}{J}\right) + Q_1 = 0 \quad (3)$$

$$Q_1 = \left(H_2 - \frac{P_2V_2}{J}\right) - \left(H_1 - \frac{P_1V_1}{J}\right) \quad (4)$$

$$Q_1 = H_2 - H_1 + \frac{V_1}{J}(P_1 - P_2) \quad (5)$$

$$Q_1 = E_2 - E_1 \quad (6)$$



Constant temperature

Process: $T_1 = T_2 = constant$

Nonflow energy equation:

$$W_2 = E_1 - E_2 + Q_1 \quad (1)$$

$$W_2 = area\ on\ P\text{-}V\ graph \quad (2)$$

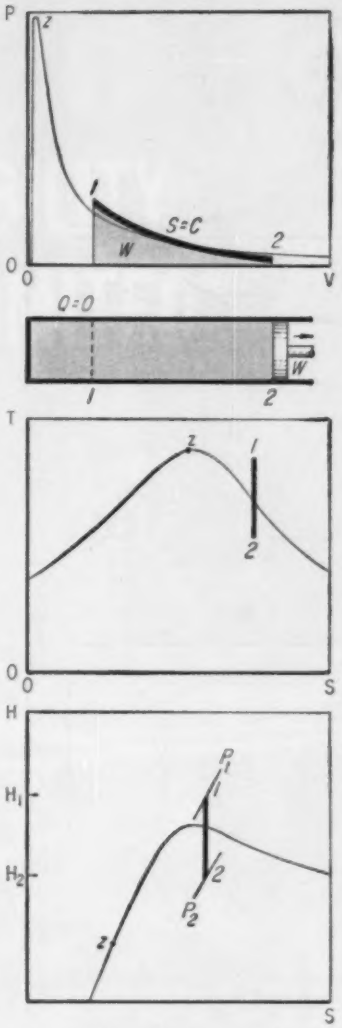
$$Q_1 = T_1(S_2 - S_1) \quad (3)$$

$$Q_1 = W_2 + E_2 - E_1 \quad (4)$$

$$W_2 = T_1(S_2 - S_1) + E_1 - E_2 \quad (5)$$

$$W_2 = T_1(S_2 - S_1) + H_1 - H_2 + \frac{P_2V_2 - P_1V_1}{J} \quad (6)$$

(Compare with perfect-gas equation where $E_1 = E_2$)



Constant entropy

Process: $S_1 = S_2 = constant$

Nonflow energy equation:

$$W_2 = E_1 - E_2 + Q_1 \quad (1)$$

By definition for adiabatic process:

$$Q_1 = 0 \quad (2)$$

$$W_2 = E_1 - E_2 \quad (3)$$

$$W_2 = H_1 - H_2 - \frac{P_1V_1 - P_2V_2}{J} \quad (4)$$

Steady-flow energy equation:

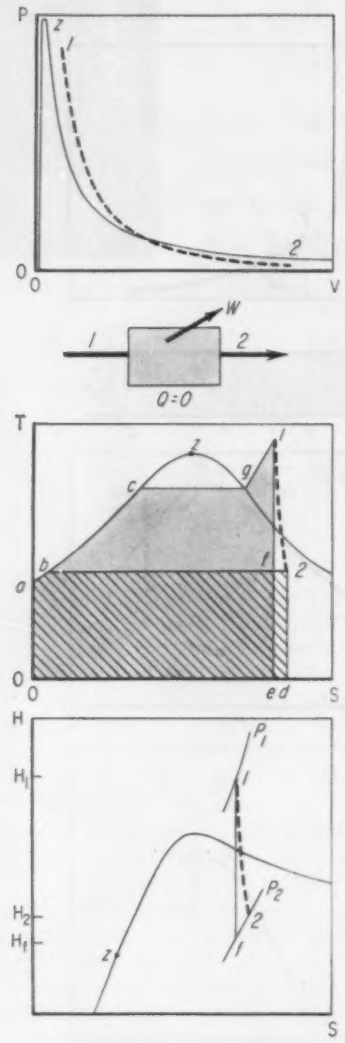
$$W_2 = H_1 - H_2 + E_{k1} - E_{k2} + Q_1 \quad (5)$$

$$\text{for } E_{k1} = E_{k2} \quad (6)$$

and since $Q_1 = 0$

$$W_2 = H_1 - H_2 \quad (7)$$

► continued



Irreversible adiabatic

Process: *Irreversible adiabatic*

Steady-flow energy equation:

$$W_2 = H_1 - H_2 + E_{k1} - E_{k2} + Q_1 \quad (1)$$

By definition:

$$Q_1 = 0 \quad (2)$$

Assuming $E_{k1} = E_{k2}$

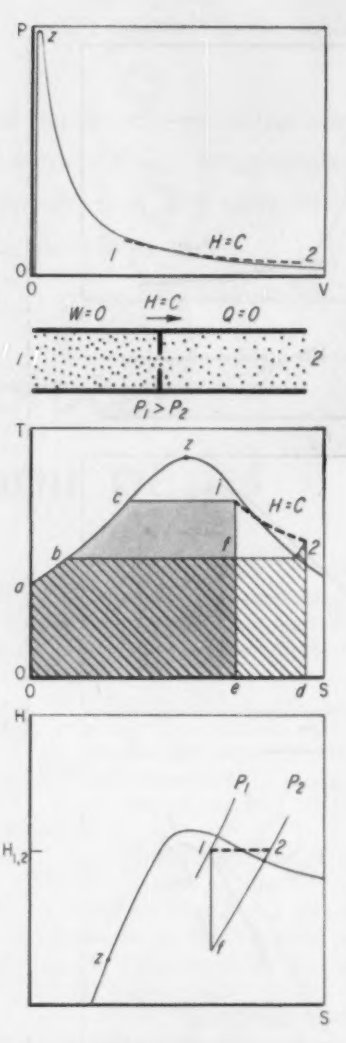
$$W_2 = H_1 - H_2 \quad (3)$$

Comparative constant-entropy process would produce:

$$W_{2s} = H_1 - H_f \quad (4)$$

Irreversibility raises unavailable energy at state 2 by:

$$E_u = T_2(S_2 - S_f) = H_2 - H_f \quad (5)$$



Throttling

Process: *Throttling*

Steady-flow energy equation:

$$W_2 = H_1 - H_2 + E_{k1} - E_{k2} + Q_1 \quad (1)$$

By definition:

$$W_2 = 0 \quad (2)$$

$$Q_1 = 0 \quad (3)$$

$$E_{k1} = E_{k2} \quad (4)$$

Then it follows:

$$H_1 = H_2 \quad (5)$$

Though no energy leaves steam, its unavailable energy rises by:

$$E_u = H_2 - H_f \quad (6)$$

Here the steam changes from an initial wet mixture at a lower pressure to a superheated steam at a higher pressure. The process line again crosses the saturated-vapor locus. Note that process lines on the *T-S* and *H-S* graphs are more steeply inclined than for a constant-pressure process.

Constant temperature. Here again we start with wet steam and end with superheated steam. Once all the steam becomes saturated, the charts show that its pressure drops as it becomes superheated.

Because property relations are very much involved, we seldom evaluate the work *W* from the *P-V* relations. The rectangular area for *Q* on the *T-S* chart makes it easy to calculate *Q*. Entropy *S* can be easily found in the Steam Tables, knowing P, T and moisture for the end states of the process.

Equation (3) gives the direct calculation of *Q*. (4) comes from (1). (5) relates the right-hand sides of (3) and (4). Expressing *E*'s in terms of *H*'s we get (6) to figure *W*.

Constant entropy. In this reversible adiabatic process we have no heat transferred. We assume that we start out with a relatively higher-pressure superheated steam and let it expand to a lower-pressure wet-steam state. Process lines again cross the saturated-vapor locus.

The vertical process line on the *T-S* graph ties in with $Q = 0$ since it has no area underneath. The vertical line on the *H-S* graph shows its particular utility for quickly figuring constant-entropy processes.

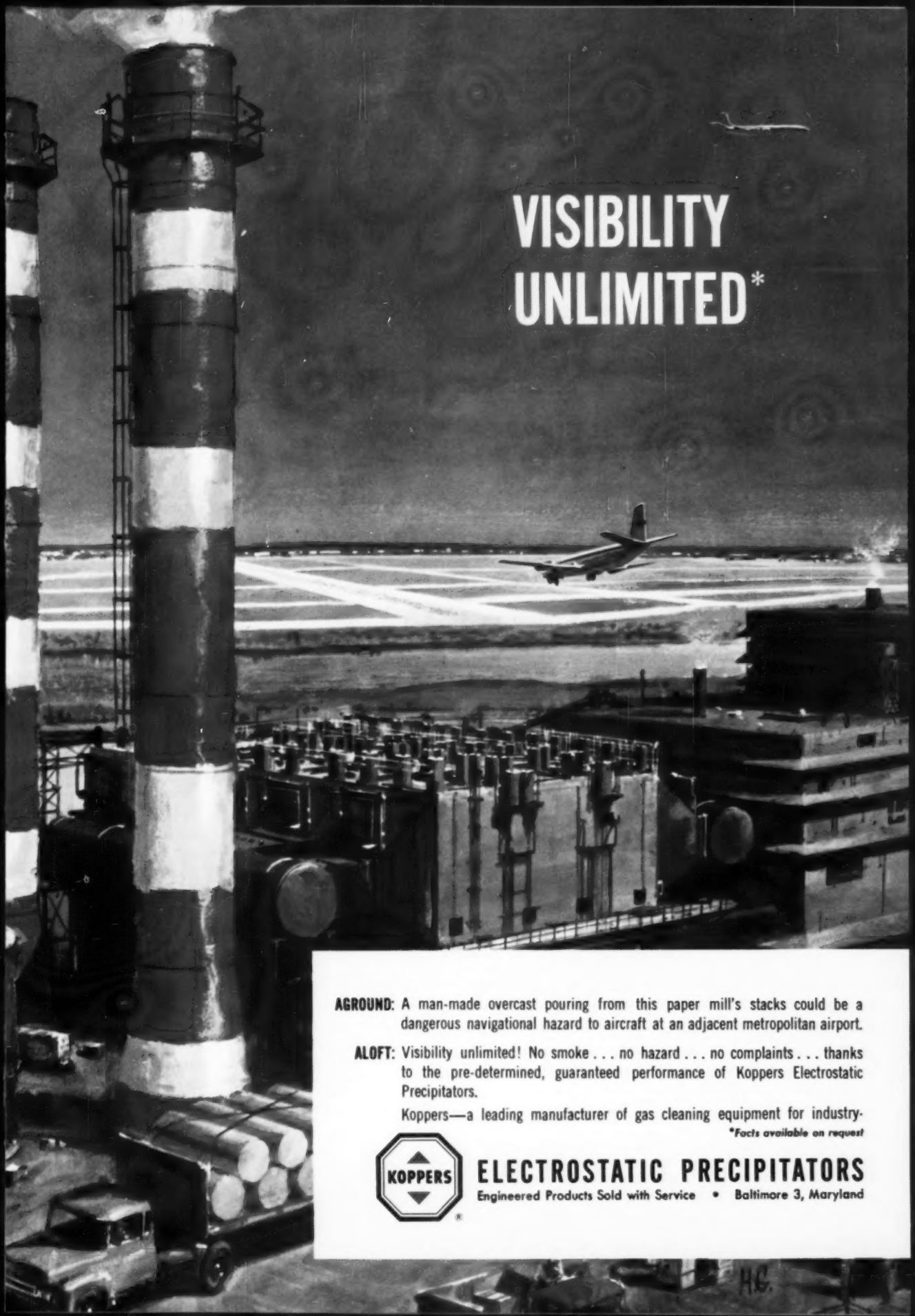
Equation (3) shows the basically simple relation for nonflow processes in terms of *E*; (4) gives it in terms of *H*. For steady-flow processes we get a simple evaluation for *W* in terms of *H*.

Irreversible adiabatic. Here we look just at a steady-flow process. It's irreversible so we draw it as a dotted line to remind us that areas underneath have no meaning. Again we start with a higher-pressure superheated steam and expand it to a wet mixture at lower pressure.

On the *T-S* graph we define the meaning of enthalpies H_1 and H_2. As said before, the enthalpies are measured above water at 32 F. In other words, $H = 0$ at 32 F for water. Then the enthalpy for steam at state

continued on p 140

Circle 279 on Reader Service card, p 103 ➤



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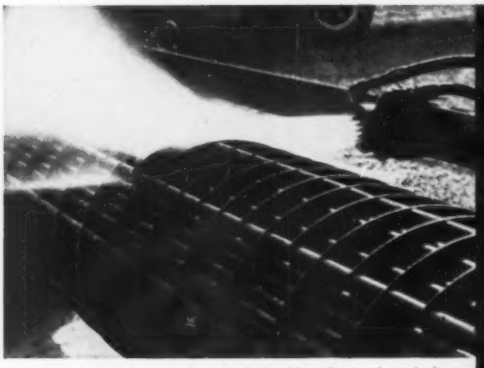
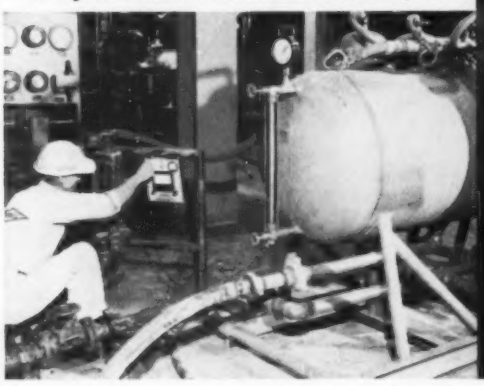


Jetting tool cleans tubes fouled with coke and asphalt.



New mobile foam-cleaning equipment cuts cleaning costs.

Cleaning missile lines and components requires tolerances as close as 150 microns.

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Industrial Cleaning. Dow Industrial Service, now a separate division of The Dow Chemical Company, offers the only nation-wide chemical cleaning service for virtually all types of industrial processing equipment. This is an expansion of the cleaning service developed over the past 20 years. Dow is currently servicing entire plants as well as doing special cleaning jobs for both large and small companies.

Dow Industrial Service research in industrial chemical cleaning has developed specialized mobile equipment and techniques, some of which are pictured above. These highly efficient techniques are improving plant productivity and reducing equipment downtime in all industries using steam generators, condensers, heat exchangers, towers, water and product lines, water wells and tanks, or similar process equipment.

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You'll find Dow Industrial Service offices and stations with specialized cleaning equipment and experienced personnel in all major industrial areas. For more information, write to Dow Industrial Service, 20575 Center Ridge Road, Cleveland 16, Ohio. *TRADEMARK

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For more facts circle 280 on Reader Service card, p 103

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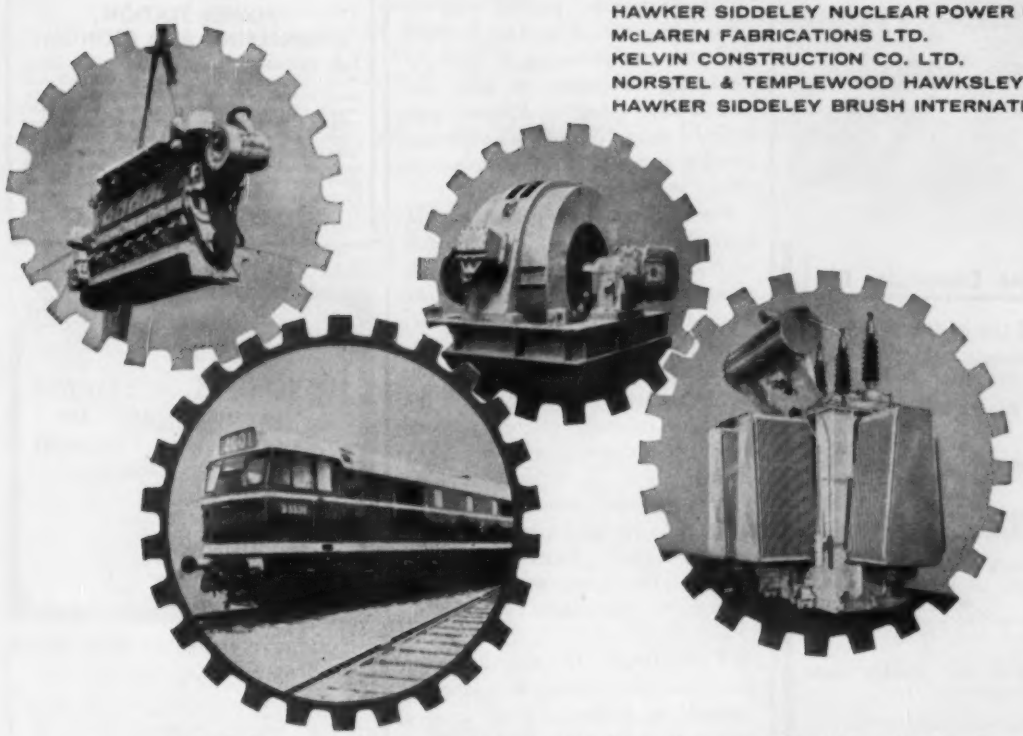

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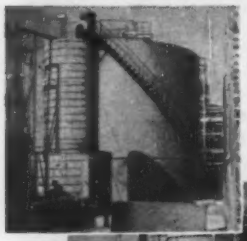
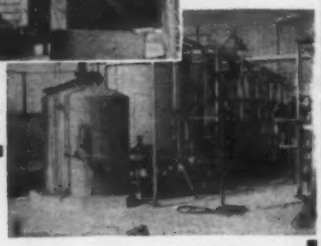
For Boiler Feedwater Conditioning Equipment



400,000 lb. per hour fully automatic demineralizer plant with silica and CO_2 removal



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A Partial List of Installations

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Akron, Ohio

Bowaters-Carolina Corp.
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Knolls Atomic Power Laboratory
West Milton, N. Y.

The Cleveland Elec. Illuminating Co.
Ashtabula, Ohio

Chevrolet Div. Gen. Motors Corp.
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H&T SERVICE

Thermo refresher

Begins on page 134

1 is made up of three parts: (1) area under curve *a-b-c* measures the enthalpy h_f to heat the water at constant pressure P_1 to saturated water at *c*. (2) Area under the P_1 constant-pressure line *c-g* measures the enthalpy of vaporization h_{fg} to vaporize the saturated water at *c* to saturated steam at *g*. (3) Area under the P_1 constant-pressure line *g-1* measures enthalpy $H_1 - h_g$ to superheat the saturated steam to state *1*. Then the total gray area under the constant-pressure line *a-c-g-1* measures the enthalpy H_1 for state *1*.

By similar reasoning, the hatched area under the P_2 constant-pressure curve *a-b-2* measures the enthalpy H_2 of the final state of the process. Line *1-f* shows the constant-entropy (reversible adiabatic) process with the same initial state *1* working between the same two pressures P_1 and P_2. Assuming no change in inlet and exit kinetic energies E_k, net area *b-c-g-1-f* measures net work of the reversible process. H_f is unavailable energy at pressure P_2.

For the irreversible process *1-2* the unavailable energy at P_2 increases to H_2; hatched area *2-d-e-f* shows amount of increase. The net work W_1 is then the difference of the two areas *0-a-c-g-1-e* and *0-a-b-2-d*. This leaves no net area on the chart that can be measured directly, as for the reversible constant-entropy process, so we use a dotted line to remind us of this.

In the Mollier chart we compare the irreversible adiabatic *1-2* with the constant-entropy process *1-f* between the same two pressures P_1 and P_2. Increase in unavailable energy is $E_u = H_2 - H_f$.

Throttling. In the throttling process we pass a steady flow of steam through an orifice or hole from a higher to a lower pressure without any energy transfer by work or heat. This is the ultimate of the irreversible adiabatic; as for gases it is defined by $H_1 = H_2$.

The *P-V* graph shows that moderately wet steam can be superheated slightly by throttling; in general, wet steam can be dried a small amount by throttling.

In the *T-S* diagram, gray area for H_1 equals hatched area for H_2. The

NUCLEAR REACTOR PLANT DATA

Compiled by the Technical Data Committee of the American Society of Mechanical Engineers

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The Marsh Radiator Valve is *truly* packless—not just *called* packless. This valve has no "packing" whatever... instead, the ingenious Marsh annular mechanical seal that keeps it drip tight throughout its far longer life.

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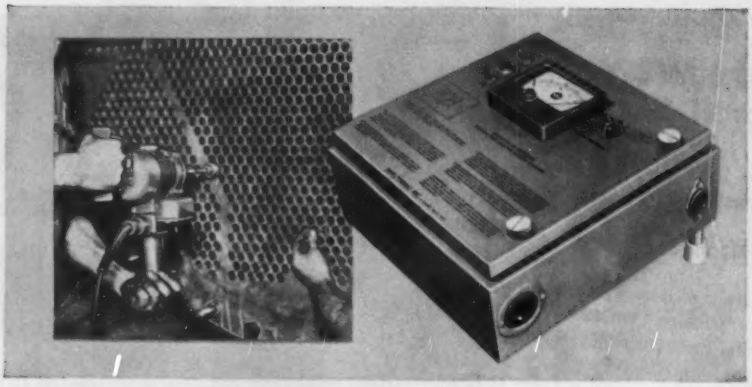

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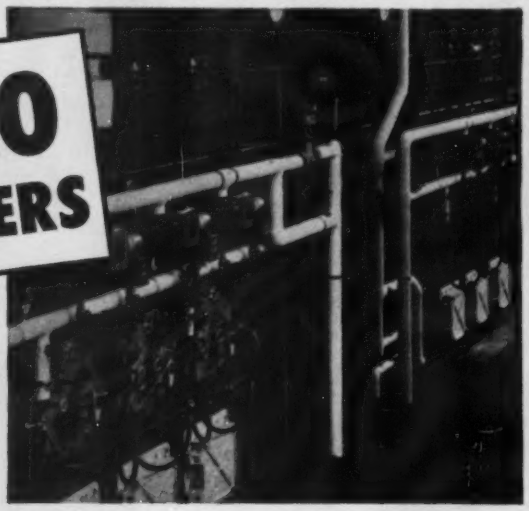

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Thermo refresher

Begins on page 134

process line *1-2* becomes nearly horizontal. Increase in unavailable energy at P_2 becomes a maximum and is measured by the hatched area *2-d-e-f*.

In the Mollier chart the process line runs horizontal since $H_1 = H_2$. Interestingly, from complete reversibility to complete irreversibility the process line swings 90 deg from *1-f* to *1-2*. Net work produced varies with degree of irreversibility.

Next month we'll try out numbers with these processes and practice using the Steam Tables.

Permutit Co offers seminars on water-conditioning problems

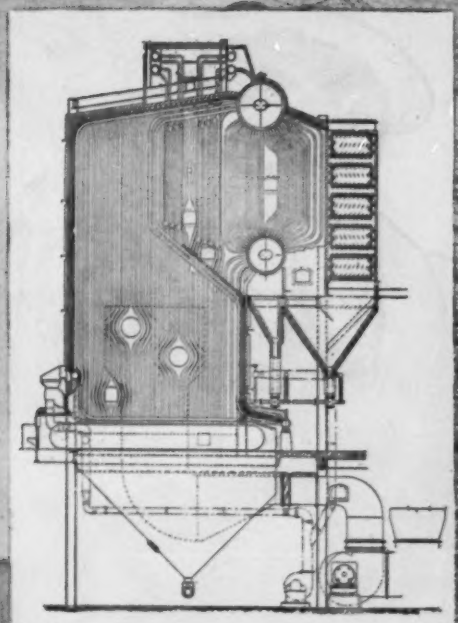
Fifty consulting engineers and plant technicians met at New York City's Hotel Astor on May 24 to attend a 1-day seminar on water-conditioning. The seminar was first of a series being offered by The Permutit Company, div of Pfaudler Permutit Inc, as an industry service. Series is designed to discuss problems arising in the plant and their possible solutions.

At this first session Permutit technical staff presented papers on: role of research and development in water treatment; contemporary methods for pretreating boiler water; techniques of degasification, deaeration and demineralization. Lectures covered production and handling of ultimate and penultimate water, current trends in treatment of condensate and modern control systems. Group discussions followed the talks.

Series was inaugurated to study increasing requirements for higher-purity feedwater for steam generation in industrial, processing and power plants. Permutit Company produces equipment and chemicals for the water-treatment field.

Swedish R-2 reactor went critical on May 4. Moderated and cooled by light water, 30,000-kw reactor produces fluxes in excess of 2×10^{14} neutrons per sq cm per sec. Allis-Chalmers Mfg Co designed experimental facilities for irradiation programs.

FUEL SAVINGS 16%



Longitudinal section of Union Type VO Steam Generator at City of Ames.

JOB: Includes delivering steam for a 12,650 KW Turbo-generator in Municipal Power Plant, City of Ames, Iowa.

STEAM GENERATOR: A Union Type VO Single-Pass (140,000 lbs./hr., 630 psi, 825° F). Fired by continuous ash discharge spreader stoker. Equipped with extended surface economizer for heat recovery. Selected for its adaptability to multi-fuel firing.

RESULTS: In continuous operation for six months, supplying total steam requirements, the Union VO was credited with fuel savings of 16%.

MORE INFORMATION: Many types and sizes of Union Steam Generators are described in illustrated Bulletin GB-959. Write: Union Iron Works, Erie, Pennsylvania.

UNION

steam generators

For more facts circle 287 on Reader Service card, p 103

"The witch doctor from the bush country did a weird dance around our hospital after his chief died there," said the surgeon

Marmy's playful diesel

Every now and then I get homesick for a deep-sea ship but the most I can do about it is to visit my old seafaring haunts along our water fronts here in Manhattan. Yesterday I was passing No. 2 Broadway, across the street from the Custom House. The old Produce Exchange building that stood there for years has been replaced by a sparkling modern aluminum-and-glass skyscraper. Several upper floors are occupied by the Moore-McCormack Lines, who also own the Robin Line.

Since my old shipmate Howard S Kennedy is now in their public-relations department, I decided to go up to the 16th floor to visit with him. Howard had just flown back from South America but he was glad to see me.

"This line has certainly blossomed out since you and I sailed aboard the old *Mormacstar,*" I said, shaking his hand. "Let's go over to the Bent Propeller Bar for lunch and reminisce over a few bottles of beer."

Twenty minutes later we barged into that international haven for seagoing globe-trotters and sat down at a table. No sooner had we ordered than that cantankerous old marine engineer, now turned consultant, entered. Marmaduke Surfaceblow saw us and navigated directly to our table. Shaking hands, he dropped anchor and lit a cigar. Soon as the waiter had put a bottle of Sandpaper Gin and two short beers before us, I said to Howard, "Remember the time we lost a propeller blade pulling into Montevideo on the *Mormacstar?*" But that's as far as I got.

"BILGEWATER on sick propellers," roared Marmy in his foghorn voice. "I'll tell you boys about the time my machinist ended up in a Capetown hospital and I inherited a diesel engine as a very playful patient."

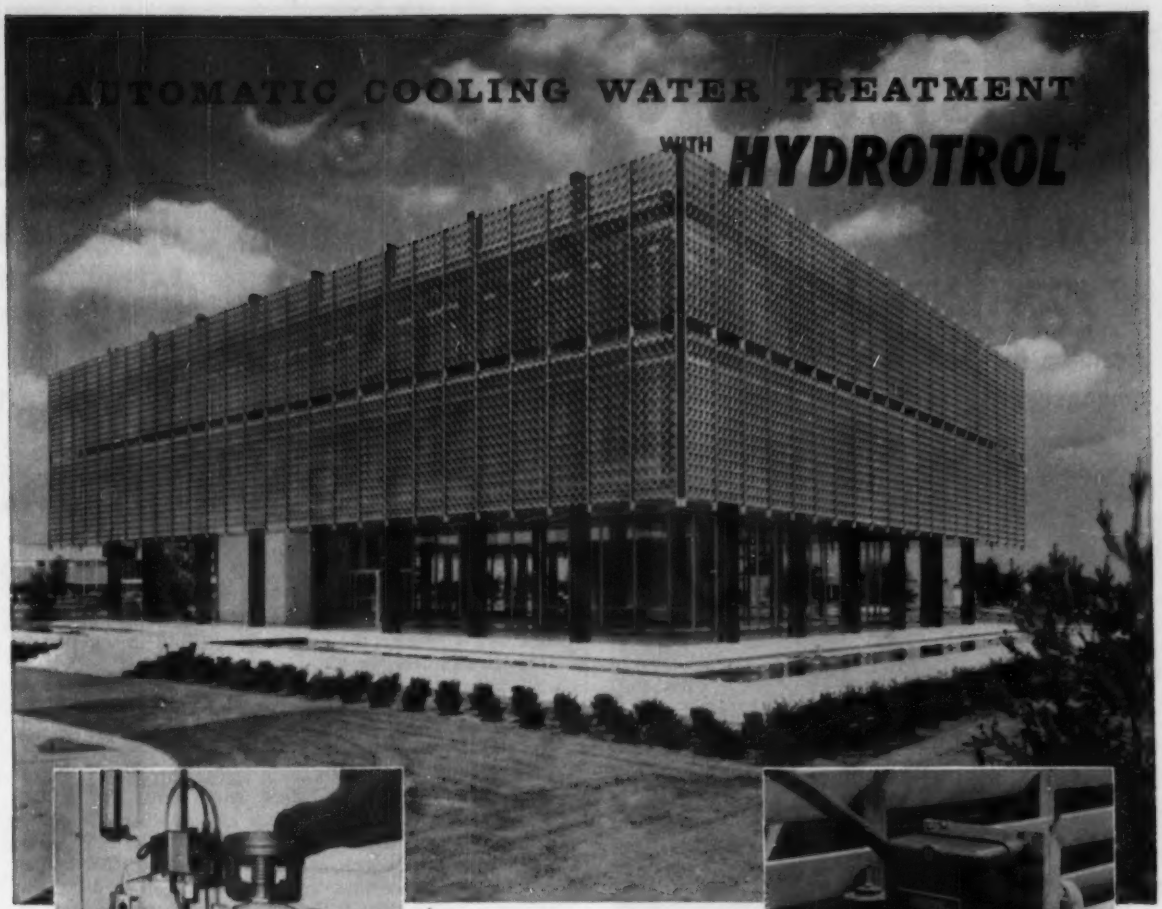
An immediate hush fell over the noisy place. Marmy took advantage of the silence to work up a 16-in. vacuum on his cargo pump and ballast his deeps from the bottle of Sandpaper Gin. Then he banged his fist down on the table, drew a deep breath and began to sound off.

"Back in 1946 the Robin Line took over the C-2 ship I brought back from the Pacific. She was converted in Brooklyn from a Navy AKA into a freighter and named the *SS Robin Locksley.*

"The *Locksley* was put on the South African run, our first port being Capetown in the Union of South Africa. From there we made Port Elizabeth, East London, Durban, Lourenço Marques, Dar es Salaam, Mombasa and finally Lamu up in Kenya, unloading cars, tires, machinery and other general cargo at each stop. On our way back we hit the same ports, picking up copper, coffee, graphite, goatskins, sisal, wattle extract, tea, mangrove extract, microlite, corundum, wine, cloves, geranium oil, wool, rock-lobster tails, fish and other cargo—mostly smelly.

"Back in Capetown my machinist got a little frisky with a local queen at a dockside pub and was carved up slightly by her boyfriend. He was a good shipmate so I dropped into the Groote Schuur hospital out on Victoria Road that

AUTOMATIC COOLING WATER TREATMENT WITH HYDROTROL*



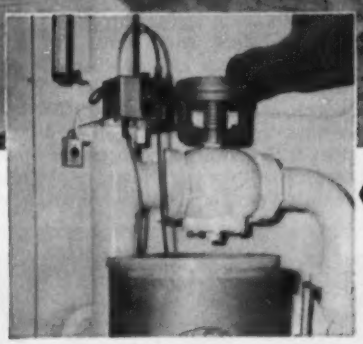
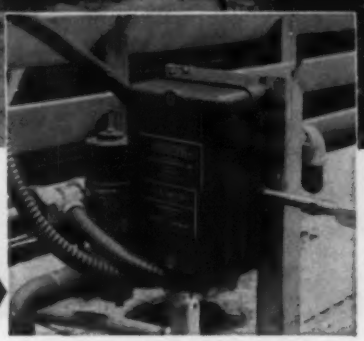


PHOTO SHOWING REMOTE PUMP FEEDING TREATMENT IN EQUIPMENT ROOM.

PHOTO SHOWING HYDROTROL CONTROL UNIT INSTALLED AT COOLING TOWER SUMP.



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HYDROTROL** is: **ECONOMICAL—FULLY AUTOMATIC—USABLE ON 20 TON TO 2000 TON TOWERS—GOOD FOR DIRECT TOWER TREATMENT FEED OR REMOTE TREATMENT FEED TO CIRCULATING LINE.

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HYDROTROL AND WATER TREATMENT DISTRIBUTED NATIONALLY BY ASSOCIATED LABORATORIES MEMBER FIRMS:

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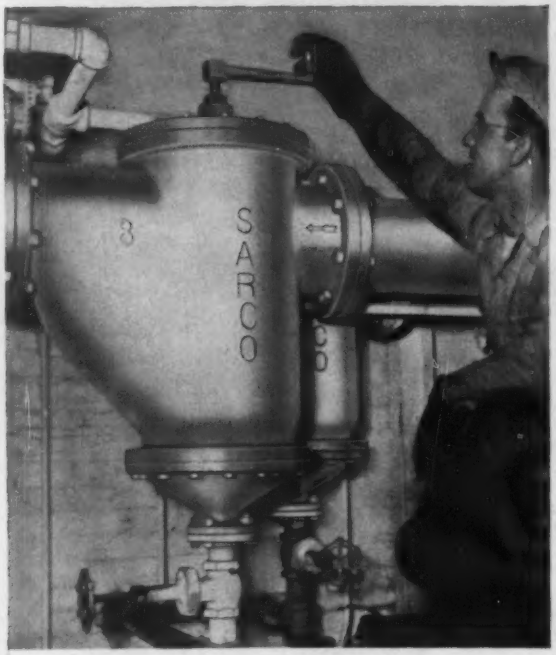
SARCO TOPICS

How correct strainer selection protects equipment, maintains fluid flow, and prevents shut-downs

Strainers for wash water for power plant condensers cleaned without shut down



Sarco Type VRS Rotary Scraper Strainers enable operators to clear the screens with a few turns of the crank, without shutting down the line or dismantling the strainer.

Sizable quantities of water are required for cleaning condenser water screens at a power plant in California. Sea water is pumped for the purpose and must be freed from debris and sea life such as mussels and sardines. Further, any screening devices used must be capable of cleaning without shut-down.

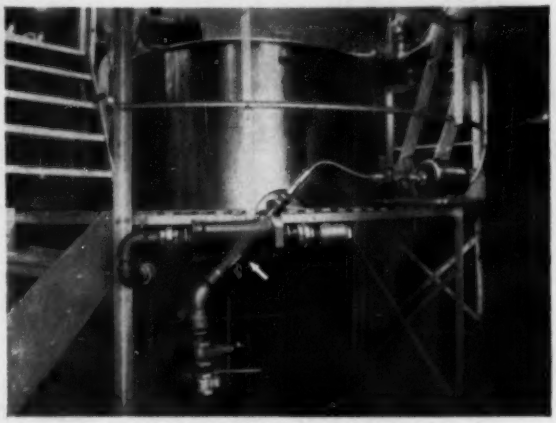
These problems were met by installing two Sarco type VRS scraper strainers ahead of the wash water pumps. This type of strainer is cleaned by rotating a spiral blade either manually or by motor drive. Motor-operated rotary-type strainers make it possible to clean the strainer continuously. The blade scrapes the screen clear, and collected solids are blown down from the strainer as required. Clean screens minimize pressure drop. The Sarco strainer installation has materially reduced maintenance hours and insured against temporary shut-down caused by clogged strainers.

Helical scraper knife clears screen without shutdown in East Chicago Air Conditioning System

Offices of the Inland Steel Company, at East Chicago, Indiana, are cooled with air conditioning units of 7½ tons and larger. Water for condenser cooling is pumped in from Lake Michigan.

Although passing through traveling screens, the incoming water still contained fine sand which clogged the screens. Frequent cleaning was required, and every now and again the units were practically out of service.

Plant engineers found their answer in Sarco Rotary Scraper Strainers, Type VRS. These units incorporate a hand-operated helical scraper knife within the cylindrical strainer screen. These scrapers made it possible to keep the strainers clean simply by cranking the scraper a few turns at regular intervals. Sand scraped off the screen is blown clear and discharged at pressure through a manually operated valve to waste. Now it is not necessary either to dismantle the strainer or shut down the unit.



IN PROCESS APPLICATION This Sarco motor operated-Scraper Strainer, Type SRS, is used to strain chocolate syrup in a processing application, providing continuous flow of fluid without shut-down for maintenance. 2167

For information on Sarco strainers, contact your Sarco sales representative, district office, or distributor; or write—

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STRAINERS • HEATING SPECIALTIES

SARCO

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condensate, steam, water, oil, and other piped fluids

PROTECT ALL EQUIPMENT
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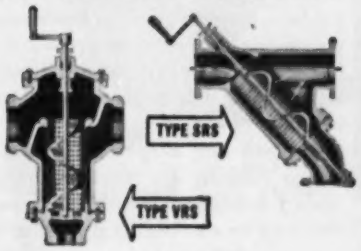
AVAILABLE IN ALL TYPES AND SIZES

SCRAPER STRAINERS
hand operated and motorized



SELF-CLEANING Y-TYPE

NEW! TYPE CT CAST STEEL. SPECIFICATION A.S.T.M. — A-216 Gr. WCB
SARCO
Tensile strength 70,000 lbs. per square inch minimum for saturated steam or liquids to 600 psi, non-shock and 750° F total temperature

Also Sarco Y-Type strainers in cast iron, brass, and semi-steel, screwed and flanged, all sizes and pressures.

For information on Sarco strainers, contact your Sarco sales representative, district office, or distributor; or write— 2166

SARCO

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PLANT: BETHLEHEM, PA.

Marmaduke

Begins on page 144

evening to cheer him up with a bottle of Block and Tackle rum.

"The head doctor of that 200-bed hospital had a jazzy title: Director Surgeon. He barged in while I visited to check up on the needlework he had done on my machinist. When the doctor learned that I was chief of the *Locksley* he asked me to stop in at his office on my way out.

" 'We have a most beastly situation here, Chief,' said the lanky British doctor as he ballasted two glasses with Scotch in his office. 'Our plant operators keep quitting and we can't obtain any local help. Dreadful, don't you know? The natives around here believe our place is haunted, cursed and all that sort of rubbish. And by Jove, at times it does appear as though some apparition or diabolic phantom were amusing himself at our expense, I must say!'

" 'Doctor,' I cut in, squinting at him suspiciously, 'You're a scientific man. I hope you're not superstitious like the natives.'

" 'There, there, my good man, just listen to my story and see if you don't jolly well agree,' he replied, leaning back and lighting a pipe. 'Our hospital is a bit antique, but we added a new wing 25 years ago. At that time we installed a 100-kw diesel-electric emergency generator as an assurance against power failure.'

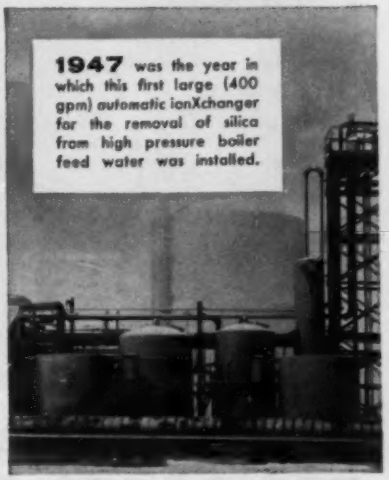
" 'We have heating boilers, ice machinery, a laundry and a few years ago put in an air-conditioning system. Our operator was a native who had been with us for over 20 years. He was an excellent mechanic, most reliable and knew our plant like his own 14 offspring. But he quit a year ago. Since then I dare say we've had a half-dozen so-called operators at different levels of efficiency. But good or bad, they all walk out.'

" 'Why?' I asked, throwing a gullet-washer of Scotch down my hatch to ward off the tropical fevers.

" 'Well,' began the good doctor again, stroking his bushy red beard as if deep in thought, 'every single month for 24 years our emergency generator has been tested and logged. Mr. Qumbu, our operator, would descend into the basement to test it. I have always checked the logbook

PATHWAYS OF A PIONEER

ILLCO-WAY DESIGNERS AND BUILDERS
MODERN EQUIPMENT FOR ionXchange


1947 was the year in which this first large (400 gpm) automatic ionXchanger for the removal of silica from high pressure boiler feed water was installed.

Blazing the Way for De-I Developments

Again we bring you an example of how IWT has always been in the forefront of the development of practical and successful ion-exchange equipment. The big boiler-water de-ionizer shown above is now more than 12 years old, is still in operation, and has been joined by two more IWT units of similar size in this sprawling midwestern chemical plant. Many other early users of ILLCO-WAY ionXchange have since *added to* and *modernized* their installations as new developments became available.

The pioneering work which IWT started in 1937, with the advent of the first commercial ionXchange resins, is still being carried on — for the benefit of present users of IWT equipment, as well as future customers. New ideas, new processes, new resins, new methods of construction, new materials, new parts and accessories — all these are under constant consideration from the foundation of long experience and with the zeal of the forward look.

THIS EXPERIENCE CAN MEAN A LOT TO YOU

If you need pure water for high-pressure boiler make-up or process use, or if you are considering the use of ion-exchange for purification or concentration of chemical products, be sure to take advantage of IWT pioneering experience and specialized knowledge. *Call your IWT representative.*

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What about cost? A size-by-size comparison with conventional Tees shows TeeLets average less than 50 per cent of the cost you now pay. A W-S TeeLet, with screwed, socket-weld or butt-weld ends, requires no shaping, fitting, beveling or extra alignment. You can connect to the run-pipe at any point. Short heights mean easy inspection of the attachment weld or back-weld, if desired.

A W-S TeeLet costs less to buy, less to install than anything you can buy or make. For complete information, prices, and names of distributors, write: *Forge and Fittings Division, H. K. Porter Company, Inc., Box 95, Roselle, N. J.*

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Marmaduke

Begins on page 144

myself. That generator *always* started. But during all those years we never once had to call on the infernal machine to give us a lift.

" 'Then a year ago we had a city power failure. It was two o'clock in the morning, and just like in the story books, there had to be an operation going on. But the diesel started up immediately—with hardly a flutter in the lights. Then in about ten minutes the lights started to dim again and suddenly went out. I finished the operation with the nurse holding a flashlight—a ghastly experience, I must say!

" 'Well, I sent for Mr Qumbu at his home. When he got here the operation was over. Luckily it turned out well. I was so upset that I went down to the generator with Qumbu when he got here, ready to give him a generous upbraiding. But when he pressed the button that generator jolly well took right off like a frightened seal off an ice flow.

" 'I had him keep that bloomin' engine running for thirty minutes while I stood there with him. During that time he checked her from bilges to crow's-nest, as you marine boys say. But he could find nothing wrong.'

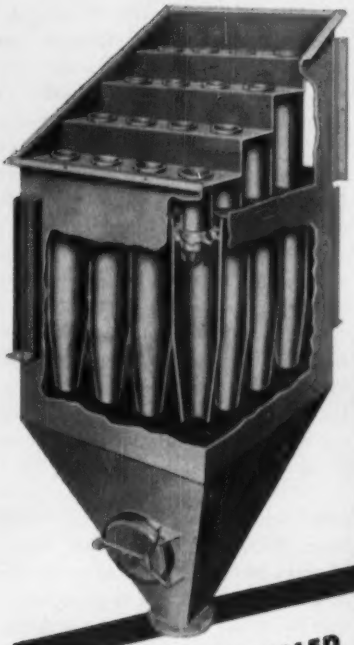
" 'Just one thing, Doctor,' I cut in, 'could anyone have monkeyed with that generator while it was running?'

" 'Never,' answered the doctor. 'Our operator has instructions to keep the key in his pocket. He always goes alone to that room to test the set. The room is just big enough to hold the machinery, so he stands in the doorway while she runs, then immediately locks the door after the test is made. Only the operator ever touches that equipment.

" 'A few days later we had another power failure,' continued the doctor, 'and within a month we'd had seven of them. You see, the local power company ran into a bit of trouble with some new machinery. Our generator always took over—then in about ten minutes she'd start to slow down, then stop.

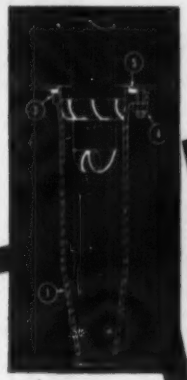
" 'Mr Qumbu got jittery and quit. He kept harping about a native chief from the bush country who died here years ago. The chief's medicine man did a weird dance around this place for two days after and must have put

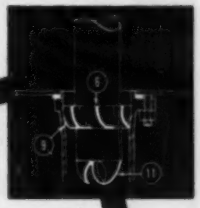
13 BIG REASONS WHY MULTICLONE FLY ASH COLLECTORS



✔ COST LESS TO MAINTAIN...
✔ ARE FAR SIMPLER TO SERVICE!

When you buy fly ash collection equipment, don't stop with a comparison of *initial* cost only. Compare also the cost and simplicity of keeping your collector at top-notch efficiency *throughout the years.* To the outstanding advantages of Multiclone's unique operating features, add the low cost and easy maintenance of this equipment and you'll see why Multiclones are the leading choice wherever *centrifugal* types of fly ash collectors are the most practical solution.





EASILY INSTALLED COLLECTING TUBES

1. **CAST IRON TUBES** assure long wear!
2. **SPECIAL ALLOY TUBES** (FBA Inco #40, Chromehard and Ni-Hard) can be supplied where high temperatures or severe erosion are problems!
3. **TUBES ARE PRECISION-CAST** for exact fit into tube sheet. Tube lip protects sealing gasket!
4. **TIGHT LEAKPROOF FIT** of each tube is maintained indefinitely by special lock nuts!
5. **GAS-TIGHT JOINT** between tube sheet and each tube is assured by special gasket. Joint can be easily renewed when replacing tube!

PRECISION CAST VANES!

6. **CAST IRON VANES** resist erosion!
7. **SPECIAL ALLOY VANES** (FBA Inco #40, Chromehard and Ni-Hard) can be supplied where high temperatures or severe erosion are problems!
8. **VANES ARE EASILY INSTALLED** by simply dropping new ones into place when changing collecting tubes!
9. **EXACT FIT OF EACH VANE** in the tapered collecting tube prevents erosive "blow-by"!
10. **CAPACITY AND EFFICIENCY** of the unit can be quickly altered by simply changing vanes. Assures easy adaptability to new operating requirements — big savings in plant modernization programs!
11. **SPIROVANES** (energy recovery devices) may easily be added to outlet tubes of existing installations to increase capacity or reduce pressure drop!

Plus These Important Advantages...

12. **CUBIC SHAPE** of Multiclone is easier to install and insulate — and requires only ONE simple inlet and outlet duct!
13. **BACKED BY OVER 3300 INSTALLATIONS** serving a wide cross-section of industry, each Multiclone benefits from the unequalled "know-how" gained during Western Precipitation's half-century of leadership in the highly-technical field of modern fly ash collection!

Compare the above advantages with any competitive equipment and you'll readily see why Multiclones are the logical choice for *your particular* operations, too. There's a Multiclone representative near you who will gladly supply further details to fit your individual requirements. No obligation, of course!

Send for descriptive literature on Multiclone equipment.

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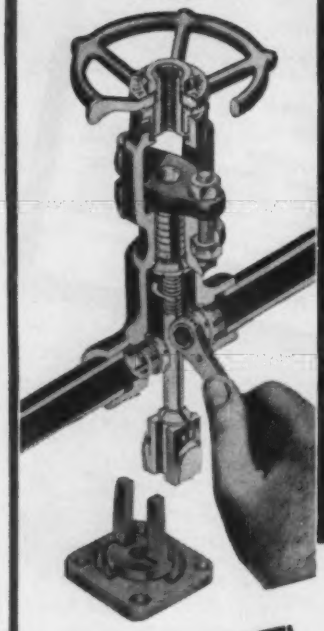

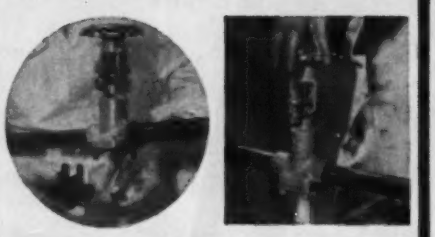

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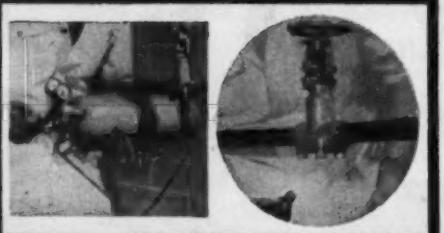
IN THE LINE



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MAINTENANCE 50%

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Marmaduke

Begins on page 144

an evil curse on us. So Qumbu decided that generator's stopping was part of his hex. Since Qumbu left, we've found it next to impossible to keep native help in the hospital.

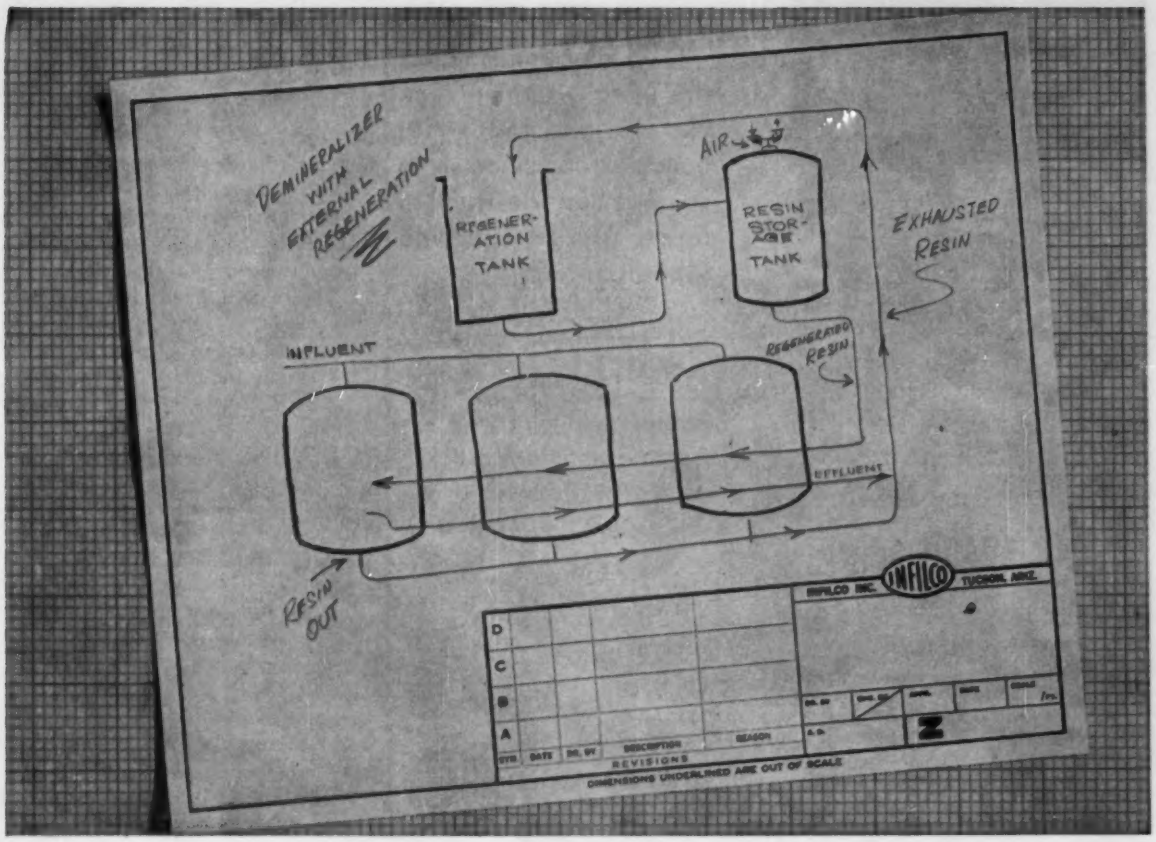
" 'Of course, I really didn't believe in the curse. So I got an engineer from our local power company to come over. He made it clear he wasn't a diesel man, but said he never saw a machine to stop him. When he arrived I joined him and our new operator as they examined our generator. The power man pressed the button and that set started up pronto. He squeezed inside the room while our new operator and I watched from the door.

" "She's a sweet-running putt-putt," said the power man after a half hour. With that he shut her down. My man locked the door as we started down the hall. "Let's stop in here," said the power man as we came to the air-conditioning-machine room.

" 'Suddenly he pulled the main circuit breaker on the city line. Everything stopped. The lights blinked for a second, then came on: the emergency generator had taken over. We went back, unlocked the door and walked in. She was simply cooing, as a well-behaved generator should. The power man shut her down, then went back and threw in the circuit breaker. It was a hot day and we needed the air conditioning. As you know, that little generator is only sized to handle emergency equipment and lighting.

" 'Well, the engineer left, but came back the next day. This time we stayed in the air-conditioning-machine room after the emergency generator took over. The lights were steady, but after about ten minutes they started to dim. They gradually went out. He threw in the circuit breaker and ran back to the generator room. Opening the door, he pressed the button. The diesel started up pronto. He spent an hour in that room looking her over. But she kept singing along steadily without a flutter. Finally he came up to my office. "I give up, Doctor," he said sadly. "At first I thought she wasn't getting enough air. But I checked her intake strainer—clean as new." He left—so did our newest operator.

" 'So, Mr Surfaceblow,' said the



ADVANCED demineralization equipment

...for specialized applications

Varied and increasingly stringent demineralized water requirements necessitate custom-made methods and equipment for many applications. Through the years INFILCO has furnished equipment for many of these "problem" jobs. These are typical examples—

INFILCO furnished the *first* high flow rate demineralizers (50 GPM per square foot) to polish condensate for a nuclear power reactor. This equipment has been operating successfully for over a year at the Vallecitos Atomic Power Plant of General Electric Company and Pacific Gas and Electric Co.

A similar INFILCO plant, having a capacity of 3200 GPM at 50 GPM per square foot, with complete external regeneration facilities, will polish condensate for the 180,000 KW dual cycle boiling water reactor at the Dresden Nuclear Power Station of Commonwealth Edison Company. This plant is discussed in Reprint 88.

Now INFILCO can furnish equipment, using these modern operating and regeneration techniques for large raw water demineralizers to produce high quality water, with less investment than would be required with other types of equipment. Reprint 92 tells the complete story.

If you have a demineralization problem, we can help you solve it efficiently and economically. If our standard line of equipment does not meet your particular requirements we can offer a custom designed plant to do the job.

INFILCO

8501

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General Offices:
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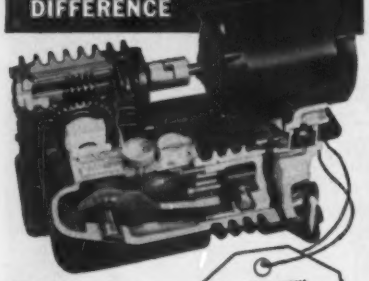
UNITIZED CONSTRUCTION MAKES THE BIG DIFFERENCE



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Unitized construction means it's completely enclosed, locked in permanent alignment, sealed against leakage, dirt and weather. All moving parts inside run in oil. Heavy duty design includes machine cut gears, outboard bearings on pump drive shaft. Solution heads of special materials available for slurries, corrosive liquids. Four standard sizes, up to 54 GPH, pressures to 300 psi. Duplex units provide twice the capacity with one motor.

Write for complete information on the new Madden METRIFLOW Metering Pump

The **MADDEN CORPORATION**
1345 Jarvis Ave Chicago 26, Ill.

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TODAY vibration isolators are literally turning commercial and industrial buildings upside-down to combat the destructive forces of vibration and shock transfer.

IN AUGUST POWER will publish a special 16-page Report outlining the latest techniques and the equipment available to solve problems in this critical area.

READ "VIBRATION ISOLATION," by Steve Elonka in the August issue of POWER.

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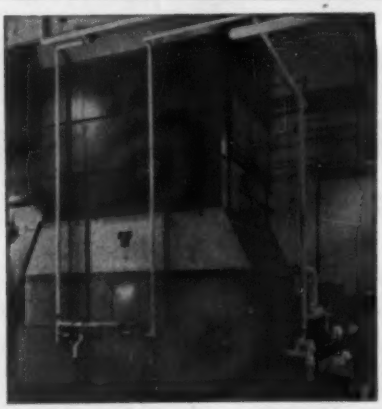

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You may apply this to solvent recovery, vacuum systems controlling reactions, condensing distillates, cooling reflux products.

For more information, write for Bulletins 120, 124, 135. Address P-7

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Marmaduke

Begins on page 144

doctor, looking at me hopelessly, 'that's our problem. We can't get the engine to keep running when it should, and we can't keep operators or other help, for that matter. We could remove the engine, but that wouldn't get our help back. Even native patients avoid our hospital as they would the plague. We must get Mr Qumbu back so the others will follow. Can you help us?'

"'Maybe,' I said, lubricating my mental gears with another Scotch. 'We'll be here for three days. I'd like to have a look-see at that temperamental engine.' Without another word we navigated below, picking up the key along the way.

"The Doctor opened the door and was about to press the button. 'No need for that,' I piped up. "I'm more impressed with the way your old operator has kept house. This machine room sparkles. I'll bet he daubed more paint on his machine rooms than your painters did in the patients' wards upstairs.'

"'What's that, my good man?' asked the doctor, as if he didn't hear me. "Oh, he was a meticulous man, right enough. But what has that to do with this engine?'

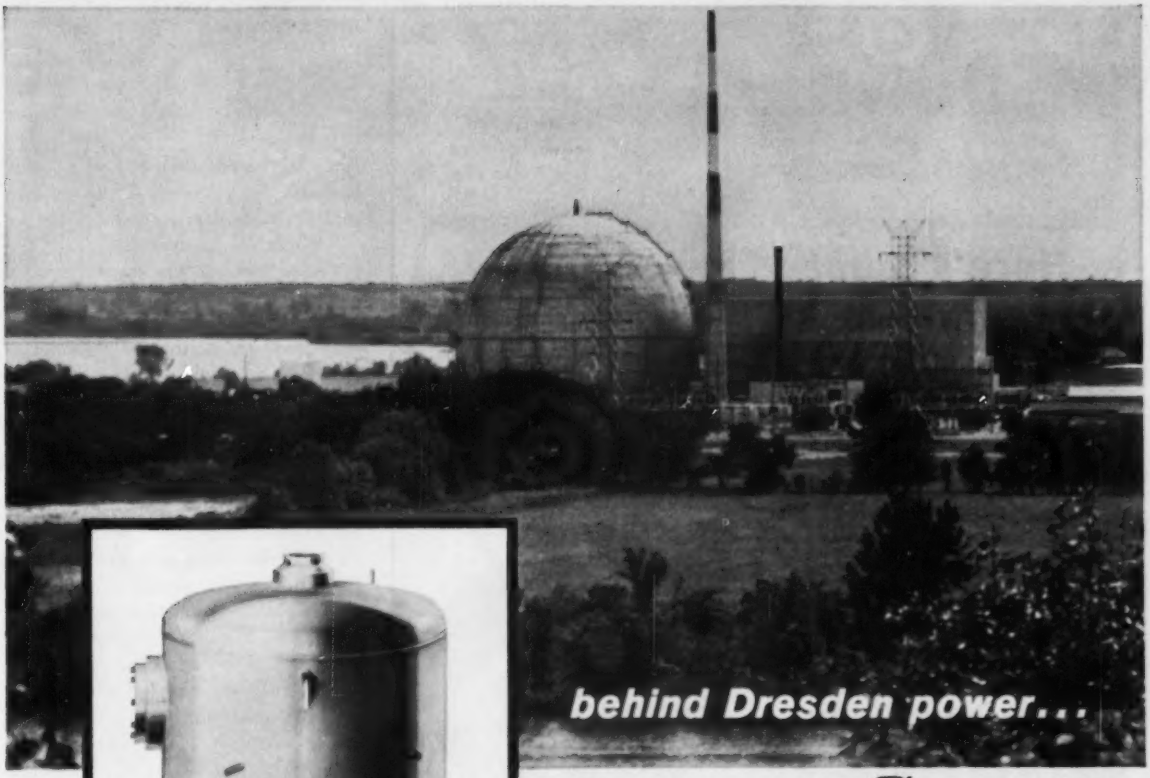
"'Just this,' I shot back. 'Maybe if he didn't smear so much paint this engine wouldn't play games.'

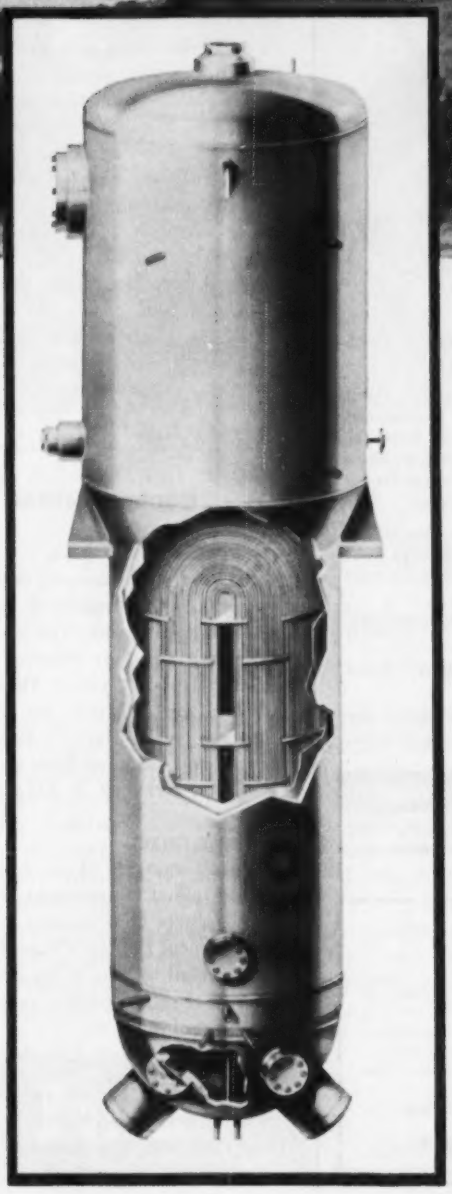
"'Paint?' echoed the doctor, giving me a fuzzy look, 'the engine hasn't been painted.'

"'Look at this wire screen on the door,' I said. 'It's been painted so many times that it's almost completely clogged. This room has no window, I notice. So what happens? Your operator comes in, opens the door and stands in the doorway while he tests the engine. She runs fine. He stops her, locks the door and leaves until the next test.

"'But during an emergency the engine starts up with the door shut. This room is almost airtight when the door is closed; the screen is the engine's only lifeline of air supply. So the engine starts up during the emergency, uses as much air as she can get, then chokes and dies.'

"'By Jove, Mr Surfaceblow, your story is positively logical. Why, all I have to do is have that paint re-





160,000 ft. of Carpenter stainless tubing

• First full-scale privately financed nuclear power plant in the United States is the new Dresden station near Chicago. This 180,000 kw. electric generating plant went on stream in April and will be in full operation later this year. A prime requirement in equipment for Dresden is *long-life dependability* to insure continuous trouble-free operation. A 33-year reputation for reliable performance is the major reason 160,000 ft. of Carpenter Type 304 Stainless Tubing is installed in a secondary steam generator (shown at left) in the Dresden dual-cycle reactor system with an output of 297,800 lb. steam/hr. at 500 psi and 467°F. Uniform working properties, concentricity and wall gauge of the tubing were important advantages in forming, assembling and installing the U-tube bundle in the unit.

Put the cost-saving dependability of Carpenter Stainless Tubing into your condensers, heat exchangers or other heat transfer equipment next time you re-tube existing units or build new units. Orders for Types 304 and 316 tubing in all popular heat exchanger sizes and gauges can now be shipped promptly from large mill stocks. Contact your nearest Carpenter office, representative or distributor for details and our latest Selecting and Buying Guide, Bulletin T. D. 120. The Carpenter Steel Company, Alloy Tube Division, Union, New Jersey.

your master key to cost-savings in power equipment

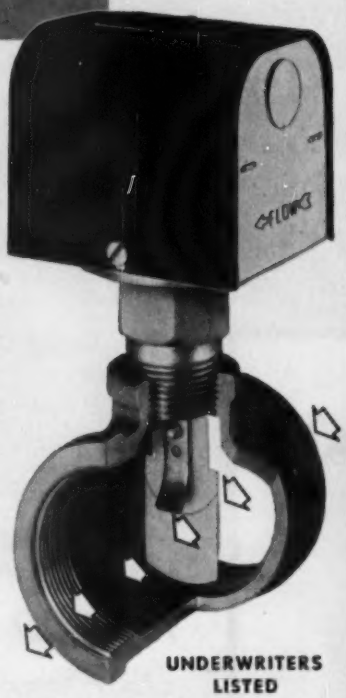
Carpenter

Stainless Tubing & Pipe

For more facts circle 297 on Reader Service card, p 103

McDONNELL *Flow Switches*

FS4 Series Flow Switch shown mounted in a 2 inch Tee

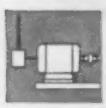


Here's what they do!

What you see here is a compact, well-built switch that makes or breaks a circuit (as required) when liquid flows or stops flowing. It's an economical and positive way to start or stop anything electrically operated. Just to highlight a few uses:

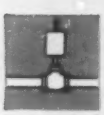
to actuate a signal light—signal an attendant to make the right moves in operating valves, pumps and the like—signal him when flow stops in a water cooled compressor, water cooled bearing and so on.

to sound an alarm—when flow stops in a process system or in any water cooled devices.



to start or stop motors—start pumps in sequence in multiple stage flow systems; start standby pumps; stop automatically controlled units if cooling water system fails; stop compressors in cooling systems when flow stops.

to start or stop automatic burners—start a booster heater when water draw occurs, stop burner if flow is improperly retarded; make sure of circulation in a boiler before burner is permitted to start.



to actuate metering device—open valve in chemical feeder line; start mixing in secondary line whenever flow starts in primary line.

UNDERWRITERS LISTED

Positive snap action switch. Easy to install and wire. Segmented paddle fits any pipe from 1" through 3". Unit shown handles pressures to 100 psi, temperatures to 300° F., in these types:

FS4-3—SPDT switch. Opens and closes two separate circuits with flow; closes and opens same two circuits with no flow.

FS4—Closes with flow; opens with no flow.

FS4R—Opens with flow; closes with no flow.

NOTE: Model E-2 available for larger pipes, pressures to 150 psi.

McDONNELL & MILLER, Inc.
3506 N. Spaulding Ave., Chicago 18, Ill.
Doing One Thing Well

Coupon brings bulletin

—covering design, construction, electrical ratings, dimensions, typical applications.

Please send me a copy of Flow Switch Bulletin FS1-A.

Company_____

Address_____

City, Zone, State_____

By_____

Mail to: McDonnell & Miller, Inc., 3506 N. Spaulding Ave., Chicago 18, Ill.

Marmaduke

Begins on page 144

moved from the door and we'll be in business again,' erupted the doctor, smiling from stem to stern.

"'Right ho,' I answered.

"Next evening the doctor sent a messenger aboard ship with four 10-pound cartons of frozen rock-lobster tails and six bottles of Sandpaper Gin. His note said, 'Qumbu is back; so are most of the others. After he scraped the paint off the screen and ran the engine with the door closed, even he was satisfied that there was no curse involved. We'll make sure our faithful diesel isn't strangled any more. I guess machinery needs understanding doctors of engineering just as people need medical doctors to keep them breathing. Toodle-pip and good luck to you and your shipmates.'

"I turned the case of lobster tails over to our steward," roared Marmy in his foghorn voice. "First night after shoving off from Capetown all 39 crew members from captain to mess boys had a feast. As for those six bottles, I used them to dissolve the scale in my own intake line."

—STEVE ELONKA

Marmy's mailbox

CHUCKLES WHILE FLYING

Read *Marmy's continuous monitor* in Feb 1960 POWER while flying from Montreal to St. John. The passengers were alarmed by my incessant chuckles but I didn't care. Thanks for making my journey so pleasant. That was one of Marmy's best stories to date, and I'm a fan from way back.

J S STEVENS, *St. John, Canada*

PULITZER PRIZE?

I suggest that all of us who enjoy reading about Marmaduke deflating stuffed shirts chip in and establish a Mechanical Pulitzer Prize. It could be presented to him at the Bent Propeller Bar after proper ceremonies at the end of the year.

E HANSON, *Cleveland, Ohio*

EDITOR'S NOTE: *He was presented an unbent propeller of Ni-Bral by Andy Woehr of the International Nickel Co (Feb 1960* POWER, *p 2).*

Public Service Electric and Gas Co. Turns Fly Ash Problems Into Profit

By using Fuller pneumatic conveying systems, the Sewaren Generating Station of Public Service Electric and Gas Company, New Jersey, was able to collect 4100 tons of fly ash during 1957. Not only did this eliminate a serious disposal problem that formerly contributed heavily to operating costs . . . it also gave the utility which sold the collected fly ash, a new and valuable source of income.

The Fuller-Kinyon system at Sewaren collects and carries the fly ash to two storage silos that have a combined capacity of 380 tons. It is then either bagged in 50-lb. lots or transferred in bulk through a Fuller loading-out silo spout to tank trucks or covered dump trucks. Labor and equipment costs are kept at a minimum. Dusting is avoided, and high tonnages are handled easily over considerable distances. Extra handling flexibility is provided by a Fuller two-way diverting valve that permits unsuitable fly ash to be pumped directly to an ash reject tank instead of to storage.

Fuller pneumatic conveying systems can be installed almost anywhere at minimum costs, regardless of plant conditions. Moisture and dirt cannot enter the system and material cannot escape. Write today for detailed information in Bulletin FF-49-1. 1334 G-282

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pioneers in harnessing AIR

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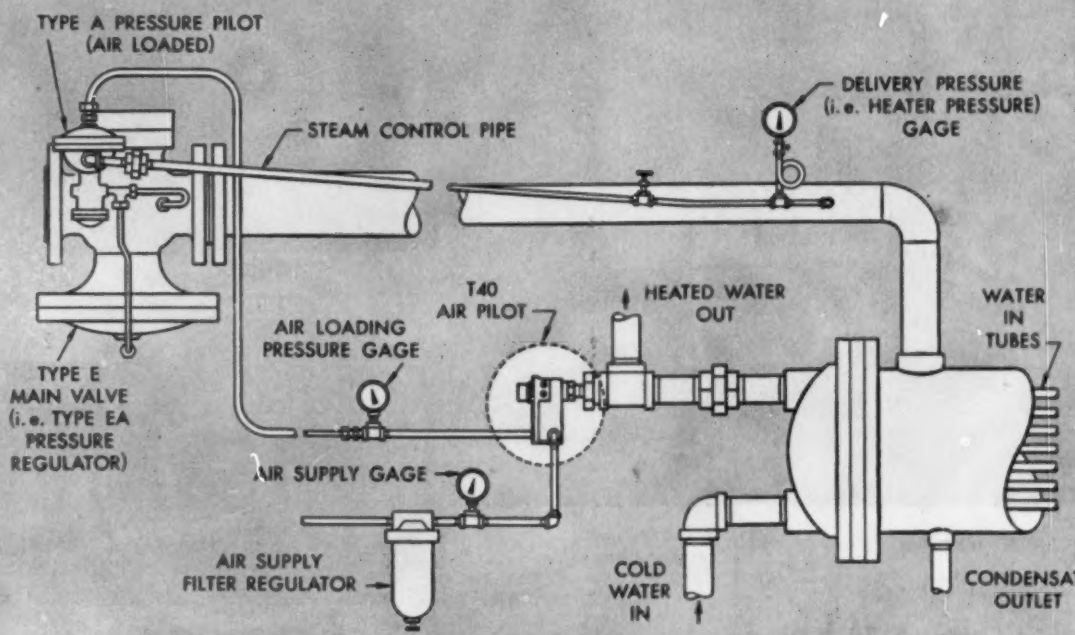
126 Bridge St., Catasauqua, Pa.
Subsidiary of General American Transportation Corporation
Birmingham • Chicago • Kansas City • Los Angeles • New York • San Francisco • Seattle

New Spence Temperature Control System Gives Unusual Control Accuracy


TYPE A PRESSURE PILOT (AIR LOADED)
STEAM CONTROL PIPE
DELIVERY PRESSURE (i.e. HEATER PRESSURE) GAGE
T40 AIR PILOT
HEATED WATER OUT
WATER IN TUBES
AIR LOADING PRESSURE GAGE
TYPE E MAIN VALVE (i.e. TYPE EA PRESSURE REGULATOR)
AIR SUPPLY GAGE
AIR SUPPLY FILTER REGULATOR
COLD WATER IN
CONDENSATE OUTLET

TYPE EAT40 AIR-CONTROL TEMPERATURE REGULATOR (Patent Pending)

In a recent installation the new Spence air-control temperature regulating system provided:

- ±5°F control accuracy under wide and instantaneous load swings of 210 to 80 gallons per minute.
- Up to 50% reduction in cost as compared to instrument systems of similar accuracy.

This unique cascade-type control with throttling range adjustment independent of maximum heater pressure was developed to meet today's demand for greater control accuracy.

Additional features of the new Spence Temperature Control System include:

- 200°F wide adjustable temperature range
- Adjustable speed of steam pressure change
- Over and under temperature protection
- Pressure limit control
- Fast response
- Very low air consumption
- Field reversible for heating or cooling

The Spence Type EAT Air Control Temperature System, when properly installed, will tame wide ranging, fast changing loads of instantaneous heaters and modern heat exchangers. The cascade principle plus the use of an extremely fast responding bi-metal temperature sensing element reduce time lags and provide control stability.

Here's how the new Spence system operates:

Quick response is based on a bi-metal temperature sensing element.

Temperature pilot continuously regulates a loading air pressure.

This loading signal, when applied to a pressure regulator to reflect heater temperatures, causes it to adjust the main valve as changes in load require.

Spence has also developed a new pressure control system based on this same cascade principle. This system has a control accuracy of ½ psi or better from positive pressures through the vacuum range to 30" Hg.

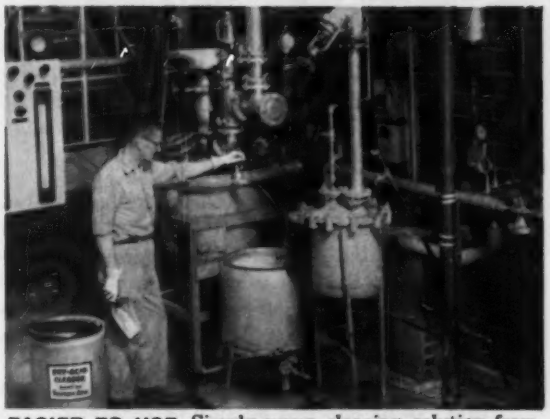
For complete information on these new air controlled temperature and pressure control systems, write for your copy of Bulletin 9.

SPENCE ENGINEERING COMPANY, INC.
Walden, New York
55-149

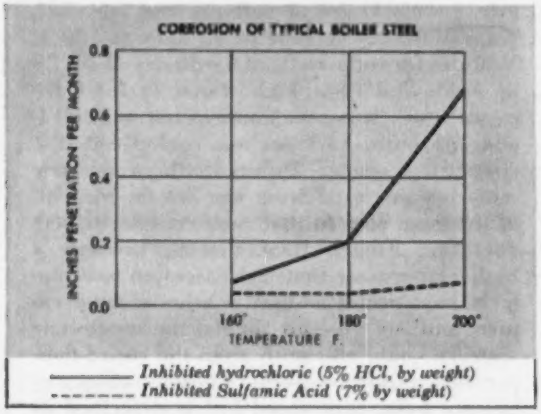
For more facts circle 300 on Reader Service card, p 103

Descale boilers, heat exchangers, condensers rapidly, thoroughly with safer **dry acid** cleaners based on **Du Pont Sulfamic Acid**

SAFER TO HANDLE. Just pour dry acid cleaner based on Du Pont Sulfamic Acid from easy-to-handle, fiber drum into make-up tank. No danger from broken bottles, liquid spillage or corrosive fumes with these dry powders.



EASIER TO USE. Simply pump cleaning solution from make-up tank into boiler. Often dry acid cleaners can be added directly to equipment being cleaned. No elaborate equipment or specially trained labor needed.



LESS CORROSIVE. Sulfamic cleaners approach the strength of hydrochloric acid, yet are far less corrosive. Excellent inhibitor stability allows their use at higher temperatures for faster scale removal.

NON-FUMING. Sulfamic cleaners produce no corrosive fumes, either dry or in solution. Corrosion in vapor spaces of equipment during cleaning operation is eliminated, along with fume nuisance to personnel.

Ask your supplier for safer, effective cleaners based on Du Pont Sulfamic Acid, or mail coupon for additional information and names of formulators who offer these compounds.

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E. I. du Pont de Nemours & Co. (Inc.)
Industrial & Biochemicals Dept., N-2533P
Wilmington 98, Delaware

Please send me ☐ sulfamic acid general equipment cleaning bulletin; ☐ names of formulators offering cleaners based on sulfamic acid.

*Name*_____

*Company*_____

*Address*_____

*City*_____ *State*_____

For more facts circle 301 on Reader Service card, p 103

Powerscope . . . A selective look at

New coal sampler

At Kingston Steam Plant of TVA a new coal sampler developed over the past eight years has gone into service. Sampler has a hollow tube pushed into the truck-delivered coal by an air hammer or pile driver. After it's driven home, two hinged leaves at the tube's bottom close to encase the coal sample in the tube, ready for removal. As the sample falls from the tube, prior to processing for analysis, layer loading of the coal can be detected. (*McGraw-Hill World News, Nashville*)

Exide Industrial Div of Electric Storage Battery Company is developing a zinc-oxygen fuel cell using compressed oxygen as the oxidizer. Zinc oxidizes in a potassium-hydroxide electrolyte as oxygen enters under low pressure. One type of cell can be recharged electrically after 16 to 24 hr of heavy use. Another type has a removable zinc electrode that can be charged outside or replaced.

Solar-heated Reds

Use of solar power in southern parts of U.S.S.R. envisions erecting about 650-million sq ft of sun-ray water-heating surface by 1980. They expect this to save about 15-million tons of coal yearly. About 80-million people in Central Asia can use this energy. Central water-heating plants would be run by hospitals, factories and public bodies. Amortization period of the heaters ranges up to four yr while the units would have useful lives up to 18 yr. (*McGraw-Hill World News*)

Free-piston engines for lake boats?

Several Canadian ship lines are studying the feasibility of modernizing several million dollars' worth of Great Lakes vessels. It seems the larger vessels and T-2 tankers could achieve faster speeds with no increase in fuel consumption, or keep present speeds at lower fuel cost. Ships would have greater cargo capacity because proposed engines and gas turbines need less space. But conversion costs may run as high as $600,000 per vessel. (*McGraw-Hill World News*)

West Coast air-pollution control

Board of Directors of the Bay Area Air Pollution Control District enacted into law Regulation 2 to control industrial air pollution. Affected industries must register with the District by Sept 1, 1960, and more-complicated industrial processes that cannot convert by Jan 1, 1961 must submit a compliance schedule by Oct 1, 1960. Regulation 2 is designed to stop most gritty or flaky emissions and end any fallout of this material near the source, drastically reduce both dark and light soiling particles, improve conditions of visibility, especially near industrial plants, largely eliminate unpleasant odors from poor combustion and eliminate vegetation damage caused by sulfur-dioxide emissions. Standards are based on concentration of solid particles and liquid droplets, total weight of dust and droplets exhausted per hr, opacity of the plume and its interference with visibility. The District, under state law, is empowered to establish and enforce pollution-control regulations in six Bay-area counties centering on San Francisco, Calif. (*McGraw-Hill World News*)

Largest thermoelectric generator

Westinghouse Electric Corporation has built a 5-kw thermoelectric generator (the largest ever) for the Navy. Unit will evaluate thermoelectric materials and techniques. The generator has modules that can be hooked up to give a wide range of voltages and currents, from 500 amp at 10 v to 42 amp at 120 v. Modules form the walls of a cylinder about 30 in. in dia and 30-in. high. Inner surfaces are exposed to a kerosene flame as hot as 1200 F and the outer surfaces are cooled by 50-F circulating water. Different thermoelectric materials are used from the hot to cold end of the generator so that each runs in its best operating range. Heat flowing through a high-temperature material passes on to a material that performs best at a lower temperature and so on—no single thermoelectric material could efficiently span the entire temperature range by itself. Thermal efficiency has not been announced but is described as three times higher than for other units.

Thermoelectric cooling now?

General Thermoelectric Corporation of Princeton, N. J. claims to have a new type of material that may make thermoelectric application to domestic refrigeration economical in the immediate future. New semiconductor material consists of bismuth, tellurium, selenium and antimony, and is called Neelium. It has a high figure of merit and low cost of manufacture. At an ambient of 131 F, it has a cold-junction temperature of –13 F. Heat-pumping capacity of the couple is claimed to be two to three times higher than that of other materials. Neelium

is made by sintering powder mixtures of the basic elements; this gives it superior mechanical as well as electrical properties, claims the maker.

Splitting a gnat's hair

Stanford Research Institute engineers have built a micromanipulator that can move a point through a distance of about 34 Angstrom units, about one ten-millionth of an inch. An atom has a diameter of about one Angstrom unit. To illustrate, the atom diameter compares with the thickness of a human hair as the thickness of this sheet of paper compares to the height of the Washington Monument. Manipulator was built to research the making of microelements that can work as tiny electron tubes. But these elements will operate by applying high electric potentials instead of heating a filament to produce electrons. This work is *mole electronics*.

Preventing fireside corrosion

Injecting anhydrous ammonia into the gas passage between economizer and air heater has been reported as preventing corrosion and hard deposits in coal-fired boilers, according to Melvin Dadd of Oglebay Norton Company. Tests show marked reduction in acidity of flyash deposits and in corrosion at the cold end of the boiler and stack. The pH of flyash rose from 1.5 before ammonia injection to 3.5 and 4 after injection when using 2-lb ammonia per ton of coal. Another test using 1.2 lb per ton lowered the acid dew point from 250 to below 100 F. Remaining flyash deposits are stickier owing to formation of ammonia bisulfate, but adding magnesium oxide to the fuel has been tried to alleviate this condition.

Piping-system design by computer

The Service Bureau Corporation, 425 Park Ave, New York 22, N. Y. (subsidiary of IBM) offers a piping-flexibility analysis within 48 hr. To use this service send a description of your piping system on data sheets supplied by SBC. Data are punched into IBM cards and processed on an IBM-704 computer. They report anchor and restraint reactions —forces, moments and stresses at all intermediate points as well as displacements and rotations. Tangents, bends and closed loops in any combination having any orientation can be analyzed. Changes to a system can be easily specified since the input data does not use coordinates for reference.

Flying on the ground

A L Haynes and D J Jay of the Ford Motor Company, in a paper read before the ASME Semi-Annual Meeting in Dallas, Texas, foresee the possibility of traveling on the ground at 500 mph. This would be by *levacars* traveling on flat-topped tracks similar to railroad tracks. Streams of compressed air fed to *levapads* that fit around the track lift the vehicle a fraction of an inch above the track surface to almost eliminate friction. An aircraft engine gives propulsive power. These vehicles would be superior to wheeled vehicles that would suffer from excessive vibration and wear above speeds of 150 mph. A levacar is an airplane except that in "flying" close to the ground it needs neither wings nor tail surfaces. One engine supplies both compressed air and propulsion. Authors believe that this system will add one more way of traveling at high speed in the future.

NBS starts plasma research

The U.S. National Bureau of Standards has started a special research program on hot gases and plasmas to meet the need of the space sciences and military developments. Techniques to be used in this program include those of gaseous electronics, astrophysics, atomic physics, microwave physics, spectroscopy, statistical mechanics, chemical physics and hydromagnetics. Biggest problem in investigating this field is the short time that plasmas are in local thermodynamic equilibrium, if ever. It's next to impossible to describe a plasma by single pressure, temperature or density values. Many scientists that ordinarily do not work together will be brought into contact in this program.

New pump-turbines on order

American Electric Power Service Corporation has ordered two pump-turbines, equaling the world's largest in size, from Allis-Chalmers Mfg Company. They will haye rated capacity of 87,000 hp at 180-ft head when generating and 4100 cfs at 197-ft head when pumping. Generator-motors are rated 101,500 hp at 106 rpm as motors and 66 mw at 13.2 kv as generators. These units are two of four for Appalachian Power Company—other two are conventional Francis design. Units will work in the double-dam project near Smith Mountain on the Roanoke River. Pump-turbines can be started up in several minutes from shutdown for generation. Pumping-operation start takes a little longer—but also can be measured in minutes.

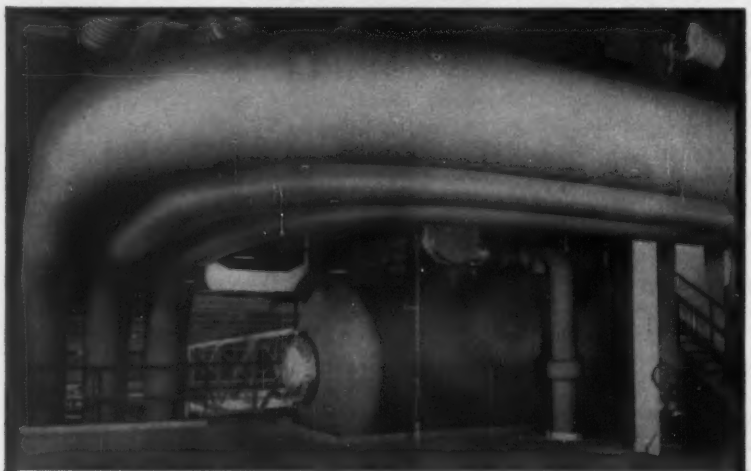
continued

Boiler Tube Service

fast
— call these representatives
PITTSBURGH Boiler Tube Co. of America Federal 1-7750
CLEVELAND Boiler Tube Co. of America Yellowstone 2-6105
CHICAGO Boiler Tube Co. of America State 2-7955
PHILADELPHIA Raphael Paul Lombard 3-7700
LOS ANGELES Fred S. Renauld & Co. Pleasant 2-6181
TAMPA John D. Homan Tampa 65-7211
ATLANTA E. W. Harbour (College Park) Fairfax 1374
ROANOKE J. J. Bower Roanoke 6-3474
NEW ORLEANS Factory Sales & Engineering Jackson 2-9151
HAVANA, CUBA Wm. P. Bryant M-9284
SAN JUAN, P.R. F. A. Ortez & Co. 2-4934

BOILER TUBE
COMPANY OF AMERICA
McKEES ROCKS, PA. (Pittsburgh District) Federal 1-7750

For more facts circle 302 on Reader Service card, p 103



ASBESTON® INSULATION JACKETING
INSURES SAFER PROTECTION

U. S. Rubber's high quality, maximum performance asbestos insulation jacketing fabric. Available in both aluminized and non-aluminized finish for both indoor and outdoor applications. For further information wire, call or write Asbeston Department.

U.S. ROYAL TEXTILES WEAVING FOR INDUSTRY

US RUBBER

Textile Division
United States Rubber
Rockefeller Center, New York 20, N.Y.

Calendar

July 6-8—Conference on Civil Engineering Education, sponsored by Cooper Union, ASCE, ASEE, U of Michigan, at Ann Arbor, Mich. Details: Dr F A Wallace, Cooper Union, New York 3, N. Y.

July 11-12—Conference on Response of Materials to High-Velocity Deformation, sponsored by Physical Metallurgical Comm., Inst of Metals Div, TMS, Estes Park, Colorado. Details: AIME, 29 W 39th St, New York 18, N. Y.

August 9-12 — American Institute of Electrical Engineers, Pacific General Meeting, El Cortez Hotel, San Diego, Calif. Details: H R Hughes, 1109 Alexandria Dr, San Diego 7, Calif.

August 15-17—American Society of Mechanical Engineers and American Institute of Chemical Engineers, Heat Transfer Conference and Exhibit, Statler Hilton Hotel, Buffalo, N. Y. Details: L S Dennegar, 29 W 39th St, New York 18, N. Y.

Sept 7-9—American Society of Mechanical Engineers, Automatic Control Conference and Exhibit, Mass. Institute of Technology, Cambridge, Mass. Details: L S Dennegar, ASME, 29 W 39th St, New York 18, N. Y.

Sept 7-15 — 2nd Coliseum Machinery Show, Coliseum, Chicago, Ill. Details: A B Perkins, 2807 Sunset Blvd, Los Angeles 26, Calif.

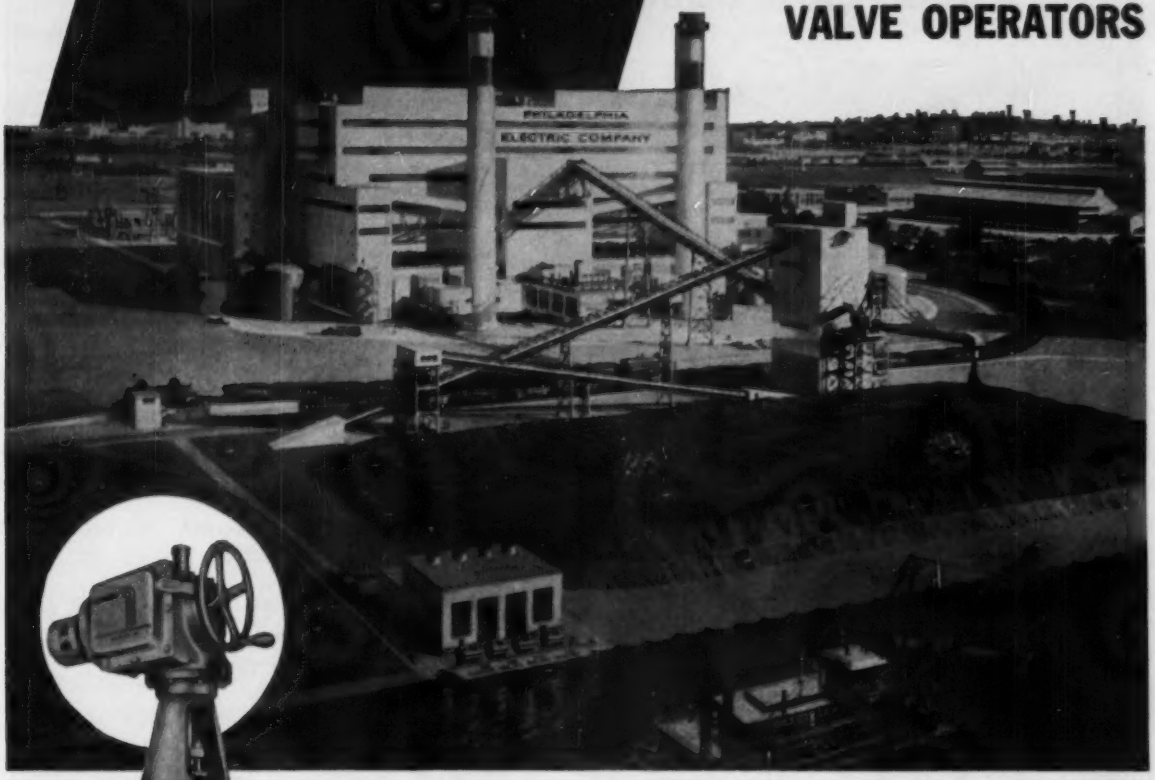
Sept 11-16 — Illuminating Engineering Society, National Technical Conference, Penn Sheraton Hotel, Pittsburgh, Pa. Details: A D Hinckley, IES, 1860 Broadway, New York 23, N. Y.

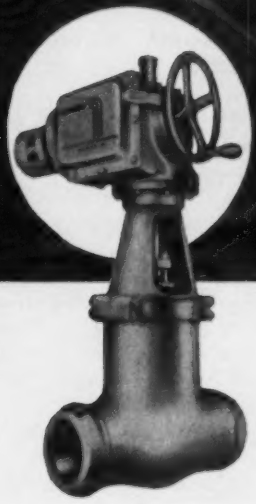
Sept 14-17 — 2nd Southeastern Annual Maintenance and Engineering Show, sponsored by AIPE, Maintenance Council, AWS, State Fair Arena, Raleigh, N. C. Details: J Harden, P.O. Box 3173, Greensboro, N. C.

Sept 15-16—American Society of Mechanical Engineers, Engineer-

For more facts circle 303 on Reader Service card, p 103

New Eddystone Station of PHILADELPHIA ELECTRIC CO.... uses LimiTorque VALVE OPERATORS





This Generating Station is one of the World's most efficient power plants . . . consisting of two 325,000 K.W. Super-critical Pressure Units.

LimiTorque Motorized Valve Operators were chosen for various steam and water applications throughout the Plant. It is significant that LimiTorque is also used in the other Generating Plants of the Philadelphia Electric Company . . . In fact, practically all of the modern generating stations in America use LimiTorque Valve Operators for assurance of dependability, accuracy, safety and economy of operation.

With LimiTorque, one key man can, from a central control point, eliminate all guesswork and labor by opening and closing valves in remote, inaccessible or hazardous locations . . . automatically, speedily, safely and dependably.

LimiTorque is available for actuation by airmotors as well as electric motors.

Should you desire to motorize existing valves of any type . . . contact your valve manufacturer or nearest LimiTorque Sales-Engineering Office.

Send for Catalog L-550 and please use your Business Letterhead.

THERE IS NO SUBSTITUTE FOR —

LimiTorque®

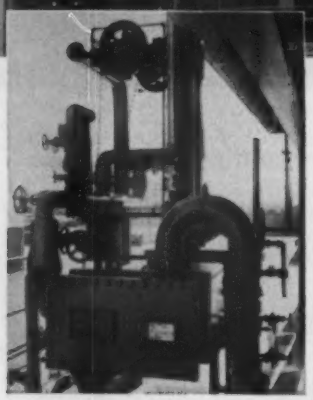
PHILADELPHIA GEAR CORPORATION
KING OF PRUSSIA (SUBURBAN PHILADELPHIA), PA.
Offices in all Principal Cities

INDUSTRIAL GEARS & SPEED REDUCERS • LIMITORQUE VALVE CONTROLS • FLUID AGITATORS • FLEXIBLE COUPLINGS
Limitorque Corporation • King of Prussia, Penna.

For more facts circle 304 on Reader Service card, p 103

BURBANK CHOOSES SWECO CUSTOM-ENGINEERED POWER PLANT EQUIPMENT

Surface Condenser, with 38,920 sq. ft. area and weighing 125 tons, condenses steam from 44,000 KW steam turbine-generator. Neoprene lining of water boxes, covers and manhole plates provides protection against corrosion.

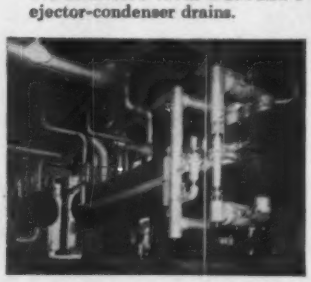


Steam Jet Ejector-Reboiler Inter and After Condenser Unit designed to remove ammonia and other non-condensibles from Burbank's ejector-condenser drains.

One of the largest surface condensers shipped completely assembled was custom-engineered and constructed by SWECO for the City of Burbank, California. Performance efficiency is above customer specifications... Winkler tests show zero oxygen in the condensate from full to 27% load... less than 4°F. terminal difference is recorded at full capacity.

A SWECO Ejector-Condenser unit with patented reboiler removes non-condensible contaminants from ejector-condenser drains. SWECO Feedwater Heaters, too, are an integral part of Burbank's recent 60% expansion of power plant output.

Leading power engineers look to SWECO's broad experience in custom-engineering and manufacturing shell and tube equipment. Illustrated literature on SWECO power plant equipment is available; write to Dept. 15-393.



Feedwater Heaters, high-pressure all-welded type units, condense bleed steam and heat feedwater.

SWECO

Southwestern Engineering Company

4800 Santa Fe Avenue, Los Angeles 58, California
Engineers - Constructors - Manufacturers

Calendar

Begins on page 160

ing Management Conference, Morrison Hotel, Chicago, Ill. Details: ASME, 29 W 39th St, New York 18, N. Y.

Sept 21-23—Power Conference, sponsored by ASME, AIEE, Bellevue - Stratford Hotel, Philadelphia, Pa. Details: ASME, 29 W 39th St, New York 18, N. Y.

Sept 25-28—American Institute of Chemical Engineers, Meeting, Mayo Hotel, Tulsa, Okla. Details: AIChe, 25 W 45th St, New York 36, N. Y.

Sept 26-30—Instrument Society of America, 3rd Instrument-Automation Conference and Exhibit, 15th Annual Meeting, Coliseum, New York City. Details: ISA, 313 Sixth Ave, Pittsburgh 22, Pa.

Sept 27-30—Association of Iron and Steel Engineers, Iron and Steel Exposition, Cleveland Public Auditorium, Cleveland, Ohio. Details: AISE, 1010 Empire Building, Pittsburgh 22, Pa.

Oct 2-5 — Society of Petroleum Engineers, Fall Meeting, City Auditorium, Denver, Colo. Details: AIME, 29 W 39th St, New York 18, N. Y.

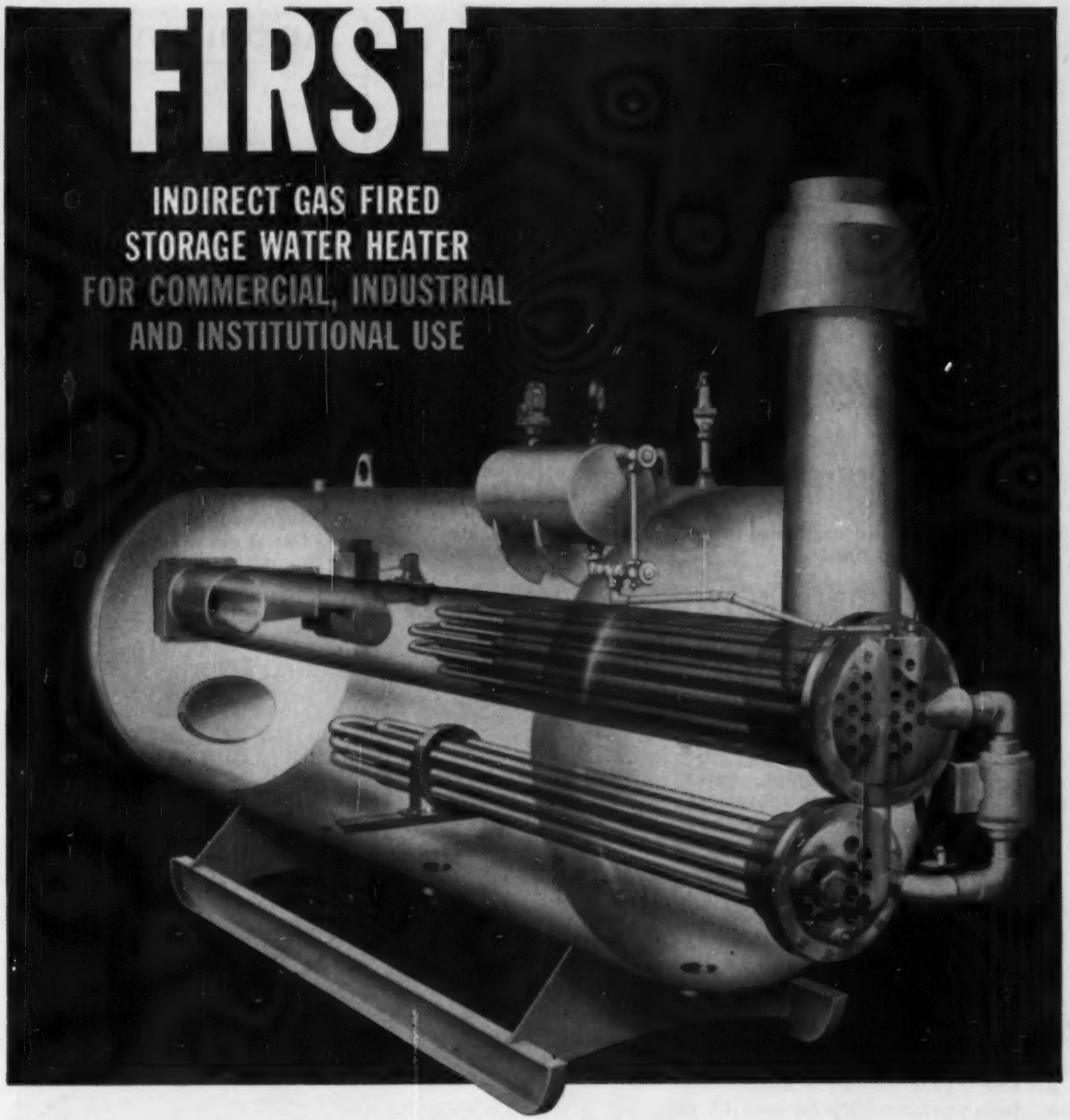
Oct 5-7 — American Institute of Mining, Metallurgical and Petroleum Engineers, Rocky Mt. Minerals Conference, Newhouse Hotel, Salt Lake City, Utah. Details: AIME, 29 W 39th St, New York 18, N. Y.

Oct 6-7—National Association of Corrosion Engineers, Annual Western Region Conference, Sheraton-Palace Hotel, San Francisco, Calif. Details: T J Hull, 1061 M&M Building, Houston 2, Texas.

Fuel cell which will convert unpurified air and hydrogen gas into electric power was demonstrated at Ionics, Inc meeting in Cambridge, Mass. Dc power the cell produces could be useful in the electroplating industry for depositing metals.

FIRST

INDIRECT GAS FIRED STORAGE WATER HEATER FOR COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL USE



No scaling • No drop-off in rated efficiency • No fuel waste • No on-the-job assembly • No complicated maintenance • No limitations on placement • Fully automatic • Copper heating surface

P-K SCALEFREE 230* is a unique rugged unit backed by P-K's 80 years of experience in building and designing quality water heating equipment. It heats water through hot intermediate distilled water. Transfer occurs below the temperature at which minerals that cause scaling precipitate. Efficiency remains unimpaired throughout service life. Linings of pre-Krete or copper are available to keep the unit free of rust and corrosion regardless of water conditions.

SCALEFREE 230 features a new P-K gas burner. It operates at maximum practical efficiency. Yet it gives almost noiseless service—does not rumble or boom on startup. This permits location almost anywhere in office buildings, institutions, schools, motels, etc.

SCALEFREE 230 is a complete fully automatic package that can be quickly set in place, hooked up and checked out. It is available in more than 100 storage and recovery combinations. Storage capacities range from 250 to 4000 gallons. Recovery sections range from 390,000 to 2,215,000 Btu. Write for catalog with full information.

*Patent pending

Patterson Kelley
104 Morgan Ave., East Stroudsburg, Pa.

For more facts circle 306 on Reader Service card, p 103

FILL IN AND MAIL TO
WESTERN CHEMICAL COMPANY
Kansas City 5, Mo.
Pioneers in the chemical control of problems relating to the use of water, steam and fuel

"I have a problem..."

- ☐ scale, corrosion, or foaming in my boiler operation
- ☐ rust and corrosion in my steam and condensate return lines
- ☐ scale, corrosion, or algae growth in my cooling or condenser water system
- ☐ corrosion or scale in my potable or plant water supply lines and tanks
- ☐ rust and corrosion in my brine or sweet water system
- ☐ scaled up pumps, water jackets, compressors, coils, lines, or equipment
- ☐ sludge and moisture in my fuel oil supply
- ☐ soot deposits in my furnace combustion areas

"I'd like to know..."

. . . exactly what specific treatment your Technical Services Dept. recommends. I understand that such problems have been your specialty for over 65 years and that you have an outstanding record for restoring and maintaining efficiency of plant equipment through advanced chemical treatment. Will look forward to receiving in the near future both your latest technical literature *and* a personal letter concerning my problem. I understand that my inquiry involves no obligation.

NAME_____ TITLE_____

FIRM_____

ADDRESS_____

CITY_____

ZONE_____ STATE_____

Mail to Technical Services Dept., WESTERN CHEMICAL CO.
713 Washington St., Kansas City 5, Mo.

Appointments

New names

Continental Controls Co: organization specializing in electrohydraulic control components and systems. **Inductotherm Linemelt Corp:** new firm will manufacture core type induction melting equipment. **Industrial Systems Div:** new name for Minneapolis-Honeywell Regulator Co operation at Beltsville, Md.

Obituaries

Raymond F Cornell, superintendent of power and control at Niagara Mohawk Power Corp, on May 20 at the age of 60.

John R Horton, general superintendent of power for Louisiana Power & Light Co, on May 9. He was 63.

James M Knox, vice-chairman of board of directors and former president of Research-Cottrell, Inc, on May 9 at the age of 56.

Jack Redpath MacCabe, senior information officer for European Organization for Nuclear Research (CERN), at the age of 45.

Joseph S Mohr, General Refractories Company regional sales manager, on May 22.

William R Moore, former Norton Company vice-president, at the age of 69.

George A Patterson, power superintendent of the National Aniline Div plant of Allied Chemical Corp, on May 15. He was 57.

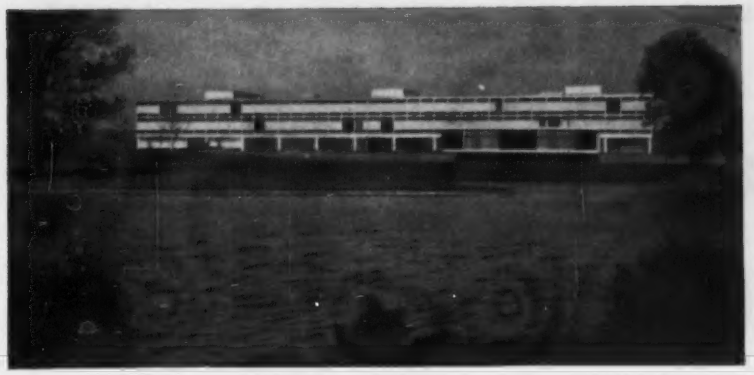
Richard W Spry, electrical engineer with Stone & Webster Co, on May 23 at the age of 56.

George R Strandberg, retired consulting engineer for Stone & Webster Engineering Corp, at the age of 71.

Millward T Thomas, founder, president and managing officer of The Thomas Flexible Coupling Company, at the age of 85.

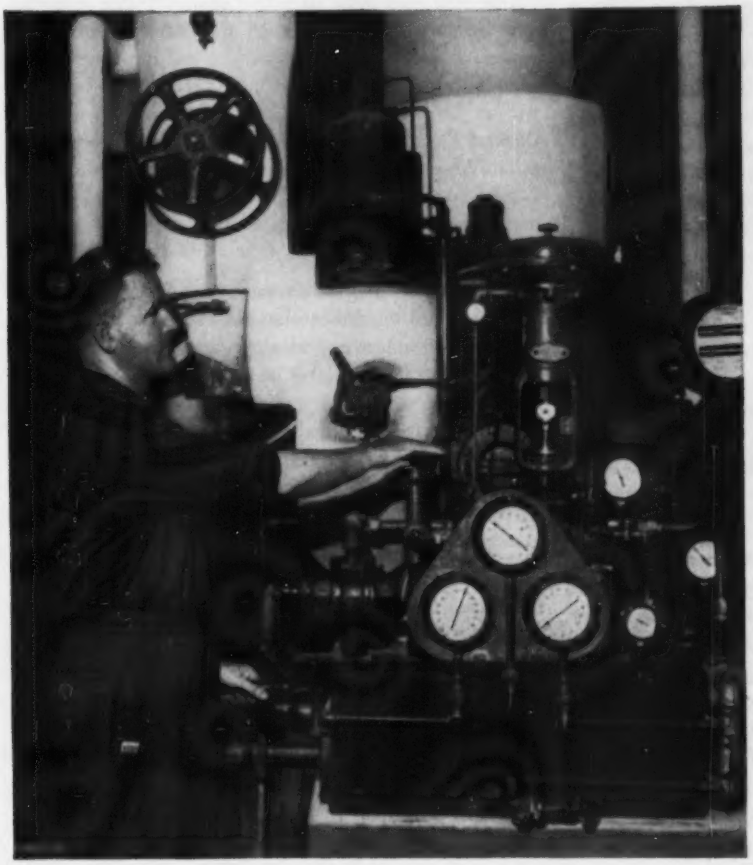
Albert Whitelaw, retired executive of Manhattan Rubber Div of Raybestos-Manhattan, Inc.

Frederic Bazin Wipperman, retired executive vice-president of National Industrial Service Association, Inc, on May 22 at the age of 68.



New home office for Connecticut General Life is a modern structure five miles out in the country.

Terry turbines power air-conditioning system at new Connecticut General Life building



One of two 870-hp, 3970-rpm Terry turbines built to drive the refrigeration compressors.

The new home office of the Connecticut General Life Insurance Co., in suburban Hartford, represents the best in contemporary architecture as well as construction techniques and materials.

In keeping with the careful planning evident throughout the project, two Terry turbines were selected to drive the York centrifugal refrigeration compressors. Terry turbines such as these have a record of low maintenance and consistent reliability under varied conditions. The steam generators, which are used for general heating during the winter months, furnish the power to operate the turbines. This provides an economical and dependable air-conditioning setup.

The steel and glass building accommodating 2500 employees overlooks New England farmland. It is furnished with modern equipment, to step up the efficiency of clerical work. Other amenities: lounges, game rooms, cafeteria, bowling alleys, barber and beauty shops, variety store, medical department.

If you are planning an air-conditioning system, perhaps you, too, should consider steam-turbine drive. Write for detailed information about the advantages of turbines for your specific requirements.

THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TERRY

T-1213

For more facts circle 308 on Reader Service card, p 103

Employee Gift Matching

Another Good Way To Help Our Colleges And Universities

The business community continues to make an impressive record in giving badly needed financial help to our colleges and universities. This year the Council for Financial Aid to Education expects that business contributions to higher education will be well over four times their total of about $40 million a decade ago.

If these contributions, which were about $150 million last year, continue to increase at the present rate, they will hit the target of $500 million set for business aid to our colleges and universities in 1970. This is the amount which, the Council calculates, must come from business if these institutions are to have the money to do their job properly a decade hence.

However, it would be a fine thing both for the nation and the business community if that $500 million dollar target were hit well before 1970. This would put us ahead of a schedule (it is a conservative schedule) in getting on top of what remains one of the nation's most crucial problems—that of having its colleges and universities adequately financed which they are very far from being right now.

There is, we believe, one quite simple way by which financial support for higher education by business firms might be considerably speeded up. All that is required is that business firms generally abandon the idea that it is possible for every company to have a program to provide such support that is novel and distinctive, and that this is the only way that interests of prestige and good public relations can be served.

There are nowhere near enough good plans to provide financial help for higher education to equip even a small percentage of our business firms with one that is novel and distinctive. Also **there are a number of very good plans which, so far as we can tell, lose nothing of their value for prestige and good public relations by being used by a large number of companies.**

The Gift Matching Idea

One plan with these attractive characteristics is the plan by which companies match the gifts of their employees to colleges and universities, and now increasingly gifts to independent secondary schools. So far as we can discover the general plan was invented by the General Electric Company, with what it calls its Corporate Alumnus Program. Now, with variations on the same basic design, almost 100 companies have gift matching plans. We at McGraw-Hill are included in this number.

The gift matching plans vary considerably in detail. Some are limited to alumni of the schools to be benefited. In others any employee can participate by making a gift to an eligible institution. There are also variations in the maximum amounts of gifts by individuals and to individual institutions which will be matched. Some companies have "open end" plans; others limit the total to be matched in any one year. All of the plans, however, embody the same central gift matching idea.

When the plan was first launched some college administrators of little faith in the fundamental generosity of the alumni and friends of their schools expressed the fear that if gifts were to be matched they might be made smaller in the first place. The opposing view was that the possibility of having them matched would stimulate more and larger gifts.

Advantages Of Gift Matching

So far as we have been able to discover, the expectation that giving would be stimulated by gift matching has been validated by the experience with the plans. This has been our experience at McGraw-Hill. Some other important virtues of the gift matching programs have been summarized by

LEADERS OF SOME OF THE INSTITUTIONS WHICH HAVE SHARED IN THE McGRAW-HILL EMPLOYEE GIFT MATCHING PROGRAM EXPRESS THEIR VIEWS

"We particularly appreciate the fact that your grant is unrestricted, and can therefore be used for our area of greatest continuing need — the General Education Fund, from which faculty salaries come."

W. Boyd Alexander, Vice President and Dean of the Faculty
Antioch College

"We are grateful, not only for the financial support given to The Cooper Union by your company, but also for the stimulus it has provided our alumni in your employ to make annual gifts to their Alma Mater."

Edwin S. Burdell, President
The Cooper Union

"The gift matching program has a dual advantage. First, it acknowledges and repays a debt of honor to those colleges which, often at great loss to themselves, have trained and educated the men who are now among your personnel. This is most fair and equitable. Secondly, by offering to match up to a given limit the contributions of alumni, you encourage support of their own colleges on the part of graduates, who themselves are so indebted."

President Edward B. Bunn, S. J.
Georgetown University

"Thanks to your doubling of the annual gifts of one of our generous and loyal friends who works with you at McGraw-Hill, we are well on the way toward creating what for us will be an extremely helpful scholarship fund. This would not have been possible without the gift matching program."

C. Adrian Heaton, President
California Baptist Theological Seminary

Ernest T. Stewart, Executive Director of the American Alumni Council (1785 Massachusetts Avenue, N.W., Washington, D.C.) who would be glad to provide detailed information about them, and the names of companies having such plans. Of the gift matching idea he says,

> "*First*—it assures the corporation that its gifts go direct to those colleges and universities which have furnished it with trained manpower.
>
> "*Second*—it places responsibilities for the gifts on the institutions themselves and drives home the point that they must make a real effort with their own alumni.
>
> "*Third*—it leaves the final decision of corporate support basically to the employees."

For many companies which are fearful of complicating their relations with their customers by courting charges of favoritism if they provide direct financial support for any particular school or group of schools, this latter consideration can be of decisive importance.

The gift matching plan also has what for many companies is the very important virtue of being simply and easily administered. Some additional virtues of the gift matching plan, as seen by officers of institutions which have been beneficiaries, are indicated in the box at the top of this page.

Effective And Easily Managed

We at McGraw-Hill are well pleased with our gift matching program. It is a broad program in which all employees and a wide array of colleges and universities, both privately and publicly supported, are eligible to participate. We commend it as an effective and easily managed plan to provide urgently needed financial aid to higher education.

We also urge that business firms adopt this or one of a number of other very good programs of financial aid to higher education* rather than delay in the hope of hitting upon some quite new and distinctive plan. There are very long odds that such delay will prove unavailing. In the meantime our colleges will be losing financial help which it is profoundly in the interest of the business community and the nation to see that they get—and get fast.

---

*An earlier editorial in this series dealt with tuition supplements as another good way to help our colleges and universities. Reprints of this editorial are available. So are copies of a "more or less socratic dialog," entitled, **A Business Wrestling with the Problem of Aid to Colleges and Universities.** It was prompted by the efforts of McGraw-Hill to find suitable methods of providing financial aid to higher education.

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nation-wide developments. Permission is freely extended to newspapers, groups or individuals to quote or reprint all or parts of the text.

Donald C. McGraw
PRESIDENT

McGRAW-HILL PUBLISHING COMPANY, INC.

Protect steel stacks with corrosion-resistant concrete

Corrosion-resistant concrete linings, made with LUMNITE calcium-aluminate cement and suitable aggregate, will protect stacks and breechings from the corrosive action of condensate.

When expanded shale aggregate is used, these linings also provide vital insulation. This keeps stack gases hot and helps maintain better draft for greater operating efficiency. The steel shell will stay cooler, too, extending the life of exterior paint. And these monolithic concrete linings have a lower unit weight, which reduces the dead load on the supporting structure.

Whether gunited or plastered, installation is easy and economical, with concrete reaching service strength in 24 hours. For even greater convenience, manufacturers of refractories offer castables bonded with LUMNITE cement – packaged mixtures ready for use with just the addition of water.

For more information, write Universal Atlas Cement, 100 Park Avenue, New York 17, N. Y.

"USS," "Atlas" and "Lumnite" are registered trademarks L-197

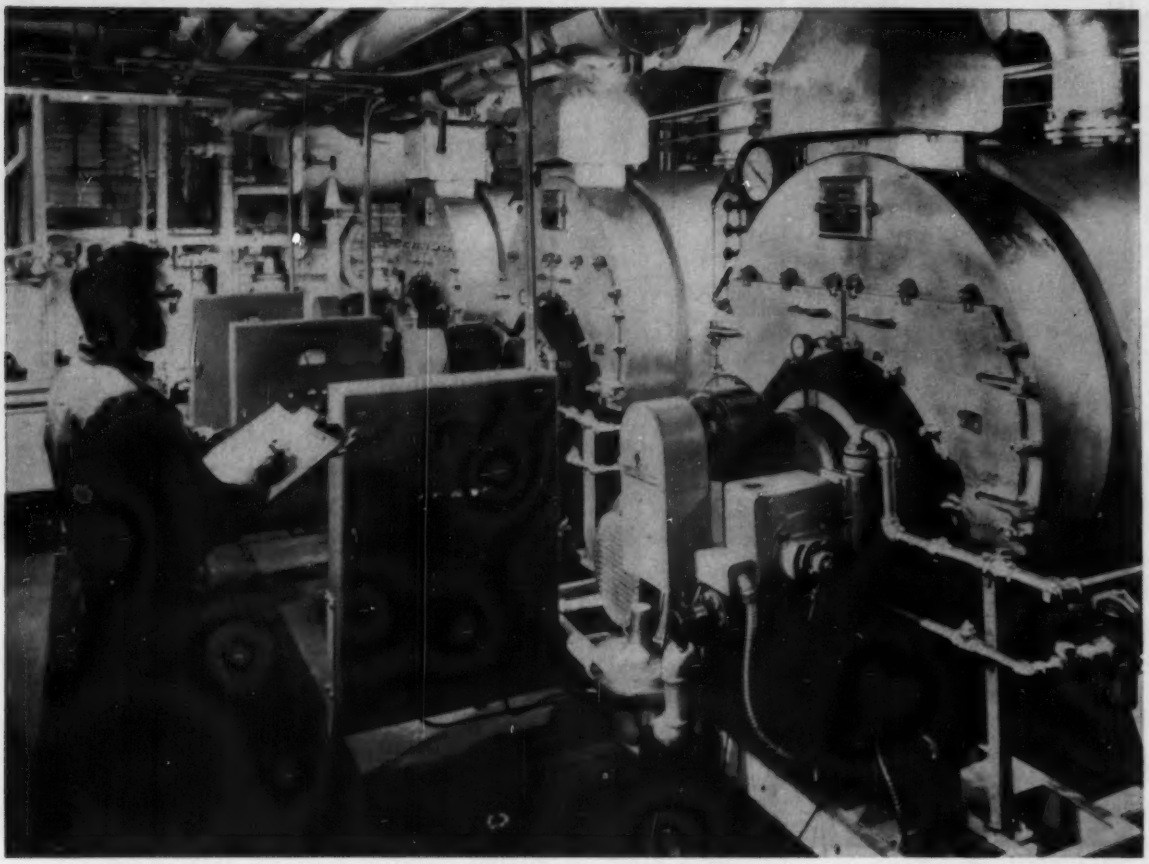
INSTALLATION: Elrama Station, Duquesne Light Company, Pittsburgh, Pa.

Universal Atlas Cement
Division of
United States Steel

Offices: Albany · Birmingham · Boston · Chicago · Dayton · Kansas City · Milwaukee · Minneapolis · New York · Philadelphia · Pittsburgh · St Louis · Waco

The smart way to modernize

. . . specify your heating plant in one package



This remodeled boiler room serves the two buildings of the Columbus Dispatch newspaper plant, Columbus, Ohio. Fuels can be quickly changed in these three Iron Fireman-Kewanee gas-oil boiler-burner units. Consulting Engineers, John Paul Jones, Cary & Millar, Cleveland; Architect, Dan A. Carmichael, Columbus; Heating Contractor, Limbach Co., Columbus.

Iron Fireman burner with boiler — engineered as a single unit

These famous boiler-burner units are the products of two great specialists—each in its own field. They are engineered for each other. Included in one catalog, they can be ordered by a single model number from one set of specifications.

Plenty of reserve power

You can feel *safe* in specifying Iron Fireman equipment. These thoroughly engineered units are conservatively rated. The normal firing rate is a comfortable cruising speed—less strain, low maintenance, quiet operation, higher efficiency —and that big extra capacity is always standing by to pick up extra loads.

Compact and complete

These complete steam or hot water generating units require little more than service connections. Automatic controls, air and fuel systems are built in. No special boiler settings; low headroom; no high stack.

Please mail coupon for catalog and specifications.

IRON FIREMAN®

AUTOMATIC FIRING EQUIPMENT
FOR OIL, GAS, COAL

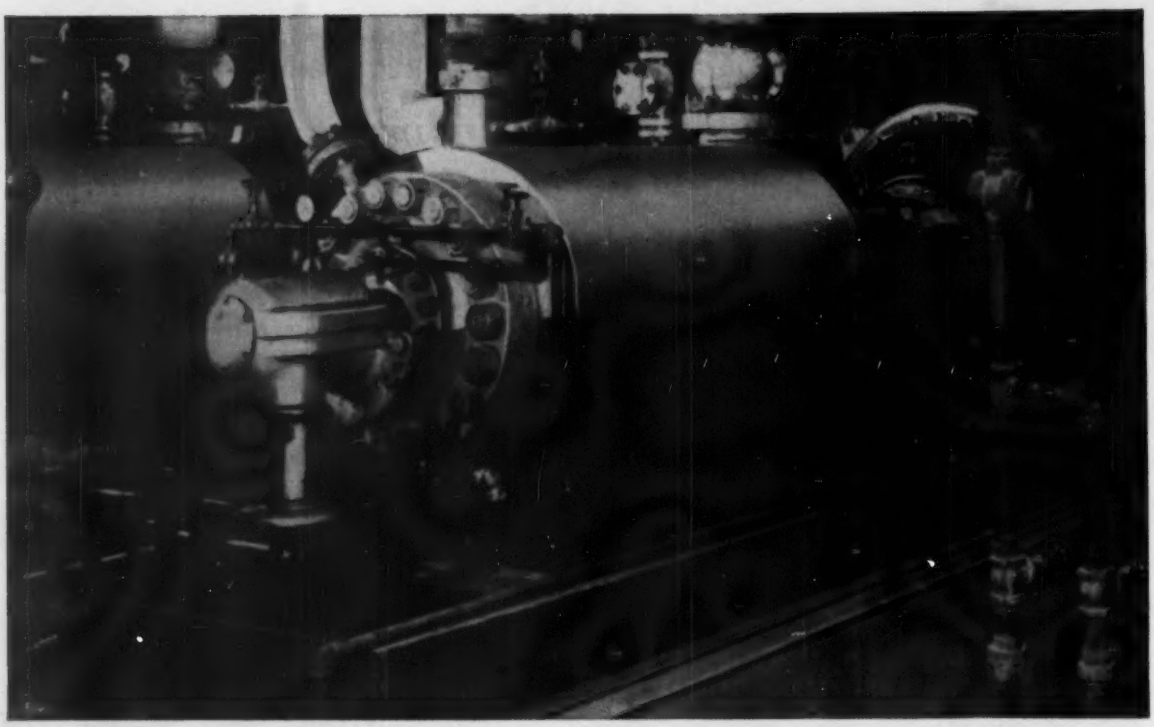
IRON FIREMAN MANUFACTURING CO.
5056 West 106th Street, Cleveland 11, Ohio
(In Canada, 80 Ward Street, Toronto, Ontario)

Please send catalog and specifications on following equipment:

☐ Complete boiler-burner units
☐ Forced draft firing unit only

Name_____
Firm_____
Address_____
City_____ State_____

For more facts circle 310 on Reader Service card, p 103



What to look for in shafts for today's high speed-high pressure pumps

In this era of soaring speeds and pressures, metals for pump shafts must have greater strength and hardness plus higher fatigue resistance. And they must be able to give trouble-free service for long periods under heavy loads.

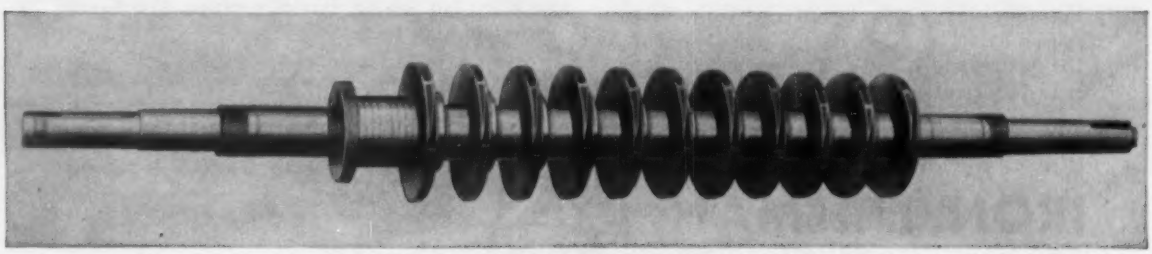
"K" Monel* age-hardenable nickel-copper aluminum alloy is one alloy which offers *all* of these properties:

- **High strength,** stiffness, and torsional properties to transmit power with minimum vibration. In "K" Monel, the designing engineer has found a non-ferrous alloy that has a high strength not offered by other corrosion-resisting alloys available at comparable price levels.
- **Hardness** to resist abrasion and scoring. This means more protection against shaft wear—longer bearing life.
- **High fatigue resistance.** "K" Monel has remarkable resistance to repeated stresses a high speed pump shaft has to undergo.
- **Corrosion resistance.** This nickel-copper alloy resists corrosion, pitting, and corrosion fatigue in waters of all sorts.
- **Galvanic neutrality,** when coupled with bronze pump bodies and bearings, or cast Monel impellers.
- **Non-Magnetic.** "K" Monel is non-magnetic under ordinary conditions, and remains so down to −150°F.

You'll find all the essential engineering data in the 28-page reference manual, "Engineering Properties of "K" Monel and "KR" Monel". We'll be glad to send you a copy.

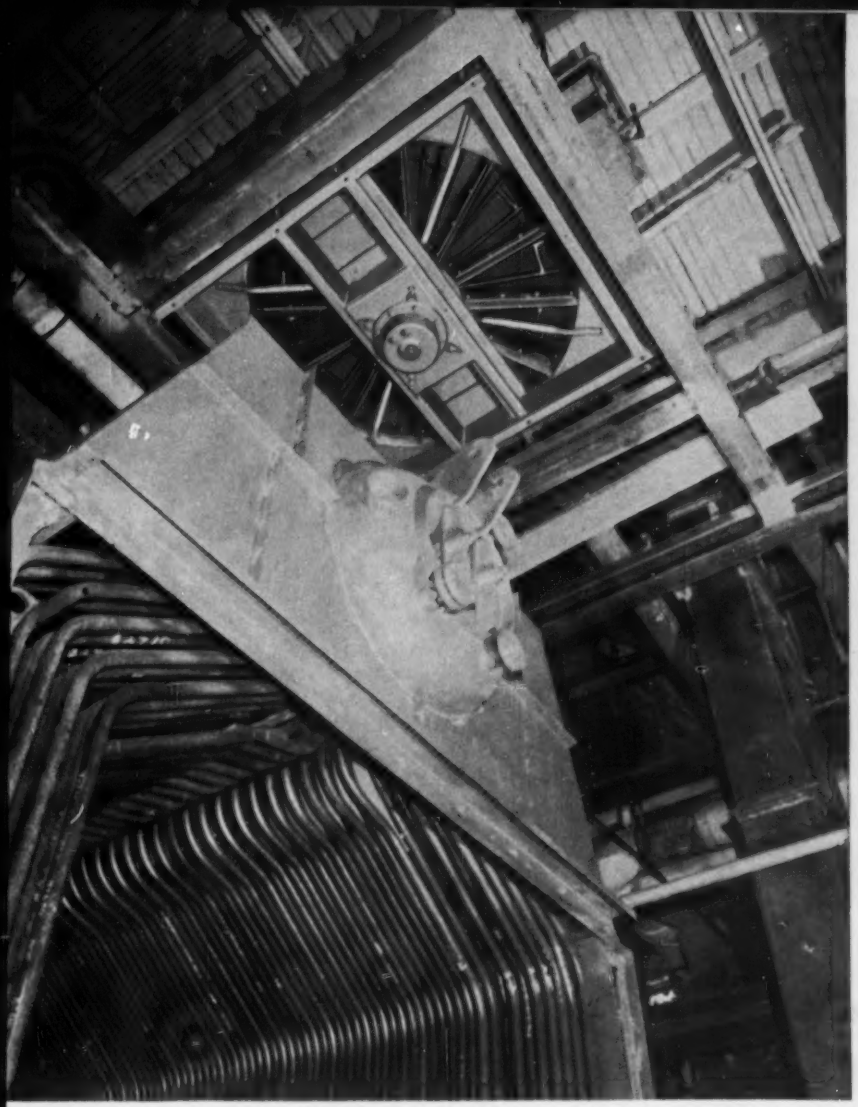
*Inco trademark

HUNTINGTON ALLOY PRODUCTS DIVISION
The International Nickel Company, Inc.
Huntington 17, West Virginia



"K" MONEL®

For more facts circle 311 on Reader Service card, p 103
circle 312 on Reader Service card, p 103 ➤



The Ljungstrom Air Preheater at the B. F. Goodrich Company Shelton Plant is installed directly over the 65,000 lb/hr Wickes boiler. Flue gas leaving the boiler at 615°F passes through the circular rotor, which absorbs the heat and releases it into the incoming air. Preheated combustion air improves combustion, makes fuel burn cleanly. This Package Air Preheater was factory-assembled, and requird only 100 manhours to install.

At B. F. Goodrich Co.'s Shelton Plant

Air Preheater boosts combustion air temperature 345°F... gives 6% more thermal efficiency

"Only a Ljungstrom® Air Preheater, with its continuous regenerative principle, could meet our requirements", says A. G. Sandomirsky, Manager of Engineering at the B. F. Goodrich Company, Shelton, Conn., plant. "We produce foam rubber 24 hours a day, five and six days a week. With an Air Preheater we can meet process steam requirements more economically, and an Air Preheater helped us to justify the installation of high efficiency, high pressure equipment for by-product power generation."

Here's why the Shelton plant meets its requirements best with a Ljungstrom Air Preheater:

1. Ljungstrom is the most efficient heat exchanger you can buy. The Ljungstrom rotor revolves continuously through the flue gas and incoming air, thus absorbing heat and releasing it *from the same surface*. Since the heat doesn't have to pass through anything, each inch of rotor surface is as efficient as one foot of a tubular recuperator.

2. Ljungstrom is the most reliable heat exchanger you can buy. All heat exchange elements pass through the entire air and gas streams. The temperature of the elements in the coolest region – where fresh air enters – is actually an average of the gas and air temperatures, so it's consistently higher than the coolest point in a recuperative heat exchanger. Result: no cold spots, less chance of moisture formation.

3. Ljungstrom is easiest to maintain. You can inspect it – and clean it–while it's running. Heat exchange elements are divided into modular baskets that can be replaced individually without disturbing the other elements. You can even reverse the elements if the surface has thinned on one edge, effectively doubling the life of the heat exchange surface.

For more information on the Ljungstrom continuous regenerative principle, or on the Air Preheater that meets your requirements, phone MUrray Hill 2-8250 or write to The Air Preheater Corporation.

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N. Y.

George Edwards

suggests: Seeing double can be a good fault

Remember the ads warning that you might have a fault and "even your best friend won't tell you"? What the ad writer overlooked was that your best friend, if he wants to keep on being your best friend, will be the last guy in the world to find fault with you. The woods are full of people quick to offer advice "for your own good."

Friendships fall into different categories, though, such as one between a salesman and his customers. Suppose the former can sell some equipment, but to do it he has to expose a weakness in customer's operating method. How can he do this without appearing to stick his nose where it doesn't belong? Let me tell you a story I heard not long ago.

The hero of our tale, a cash-register salesman, firmly believes that the average person operates at about 30% of potential efficiency. And, constantly trying to improve his own efficiency, he can't help but spot room for improvement in situations around him from time to time. He used one such situation to nail down a sale he'd been trying to make for months and did it without ruffling any feelings.

The customer operated a big chain of retail bakeries. He liked the new model register, admitted it would chop man-hour costs, but simply couldn't make the investment at that time. A nice piece of business, ripe and ready for picking, but how do you overcome sales resistance like this? Customer's management said they'd have to have a 3 to 5% increase in gross to afford the new machines.

Our salesman told the bakery people that he'd been playing around with an idea, but wanted to check it out completely before saying what it was. Problem was, it might involve a mild change in their methods and he didn't want them to feel that he was interfering in company policy.

Assured that such would not be the case, our man told them he'd be in touch in about a week. At the end of that time, and with the bakery brass assembled to hear his story, our salesman showed up accompanied by four men each carrying a large carton. Emptying the cartons, the four piled 100 loaves of the customer's bread on the table and left. As they went out the door our salesman plunked a sizable wad of cash beside the bread, then looked at the puzzled men sitting around the table.

"Gentlemen," he said, "you told me that a 3 to 5% increase in your gross sales would make it possible to invest in the registers that you want to buy and that I certainly want to sell you. Here's the result of a little experiment I ran during the past week. I think it may show that you can get the increase in gross you mentioned, perhaps more.

"I assembled 25 men, gave them each $20 and assigned each one to visit four of your retail stores. At the store they were to *ask* for a loaf of bread, but to *buy anything else the clerk suggested* up to a limit of $5 per store.

"Here on my left you see 100 loaves of bread. At 23c per loaf this adds up to $23. But here on my right is $477 in cash which also could have been yours. Being *sales-opportunity* minded can work as well for your company's people as it does for mine or any others. If you have a fine product to offer, go out and *sell* it!"

Are You Paying Big Penalties for Lagging Power Factor?

James H. Tarbell, power company engineer, (left) and Harold Toot, Vendo Production Manager, shown with the 200 hp, 514 rpm, 0.8 pf, 440 volt, flange-mounted E-M Synchronous Motor that is correcting Vendo's power factor. The Vendo Company is the world's largest manufacturer of vending machines.

Vendo Company Corrects Power Factor... SAVES $450 A YEAR! with an E-M Synchronous Motor

The Vendo Company, Kansas City, Missouri learned its plant was operating at a lagging power factor condition when expanded production facilities required more compressed air. A study by Vendo's engineers and Kansas City Power & Light Company showed an 0.8 leading power factor synchronous motor compressor drive would save them money. Here's how:

Vendo's power contract provides a penalty of 20 cents a month for every reactive kva exceeding one-half the maximum kilowatt demand. *This was costing Vendo $33.00 per month, or $396.00 a year!*

A 20 cents a month bonus is granted for every kilovar the reactive demand falls short of one-half the maximum kilowatt consumption. A 200 hp E-M Synchronous Motor with 0.8 pf would provide enough reactive kva for Vendo to operate at a *leading* power factor and earn a monthly credit of $4.60. Vendo's power bill would then be reduced by $37.60 a month, or $451.20 a year!

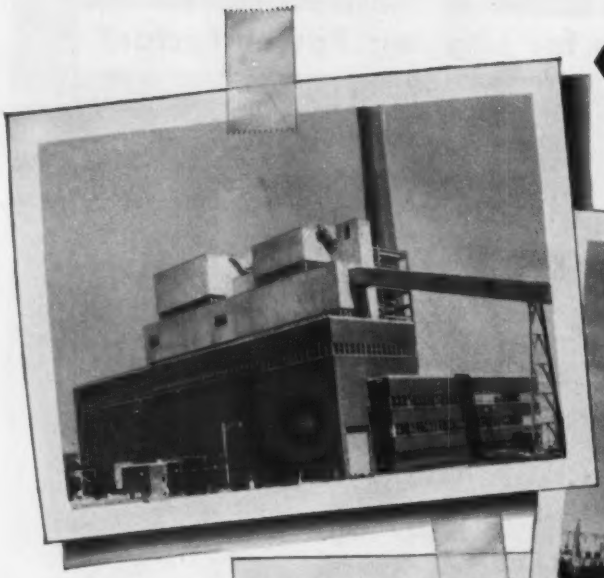
Vendo installed the recommended E-M Synchronous Motor . . . and has been enjoying a reduced power bill ever since. You, too, can make a big saving in your plant power bill by correcting your power factor with highly efficient E-M Synchronous Motors.

Learn more about Power Factor. Call your nearby E-M Sales Engineer and write for your free copy of the new E-M 24-page brochure, *The ABC of Power Factor.*

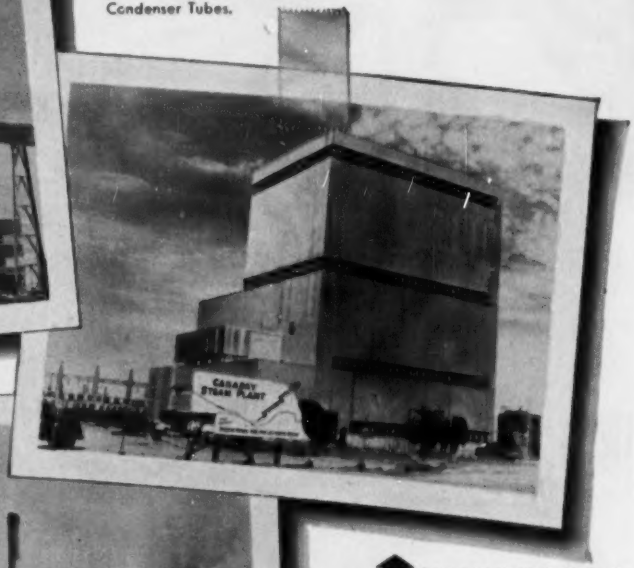
ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

Specialists in making motors do
EXACTLY WHAT YOU WANT THEM TO

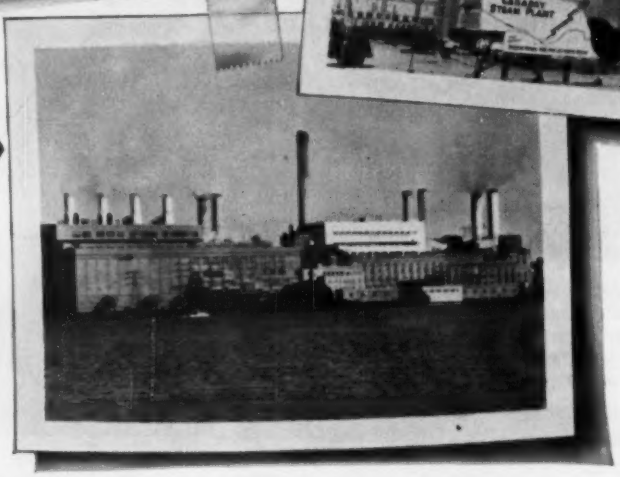
For more facts circle 313 on Reader Service card, p 103



ILLINOIS POWER COMPANY'S Vermilion Plant near Danville, Ill., with 183,000 KW capacity. #2 condenser equipped with 162,288 pounds of Revere Admiralty Condenser Tubes.



100,000 KW CANADAY STEAM PLANT of the Central Nebraska Public Power & Irrigation District. Here you'll find Revere Muntz Metal tube sheets combined with Revere Copper Condenser Tubes.



THE NIAGARA MOHAWK POWER CORPORATION'S Huntley Steam Station, Buffalo, N.Y. with 196,000 pounds of Revere Admiralty CondenserTubes and 29,000 pounds of Revere Muntz Metal tube sheets installed in its Unit #67.

TUBED BY REVERE MEANS TUBED TO LAST

A few more power companies who depend on REVERE Tubes and Plates for performance plus service

Revere's Technical Advisory Service, because of its long and varied experience, is qualified to help in the selection of the alloy best suited to the specific set of operating conditions encountered in your power plant. This experience, which has covered many and varied types of problems, has been instrumental in prolonging tube life for power plants both large and small.

Why not take advantage of this storehouse of knowledge and contact Revere before making the final selection of tubes and plates for your equipment?

REVERE COPPER AND BRASS INCORPORATED

Founded by Paul Revere in 1801

230 Park Avenue, New York 17, N. Y.

Mills: Rome, N.Y.; Baltimore, Md.; Chicago, Clinton and Joliet, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Brooklyn, N.Y.; Newport, Ark.; Ft. Calhoun, Neb. Sales Offices in Principal Cities, Distributors everywhere.

INTEGRAL FINNED TUBE • BIMETAL TUBE • INSTRUMENTATION TUBE • CONDENSER TUBES IN CUPRO-NICKEL, ALUMINUM BRASS, ADMIRALTY, HERCULOY, ARSENICAL COPPER, MUNTZ METAL AND OTHER ALLOYS. ALUMINUM TUBE, SHEET AND EXTRUSIONS. SMALL AND LARGE PLATES IN CUPRO-NICKEL, COPPER, HERCULOY, MUNTZ METAL, NAVAL BRASS AND ADMIRALTY.

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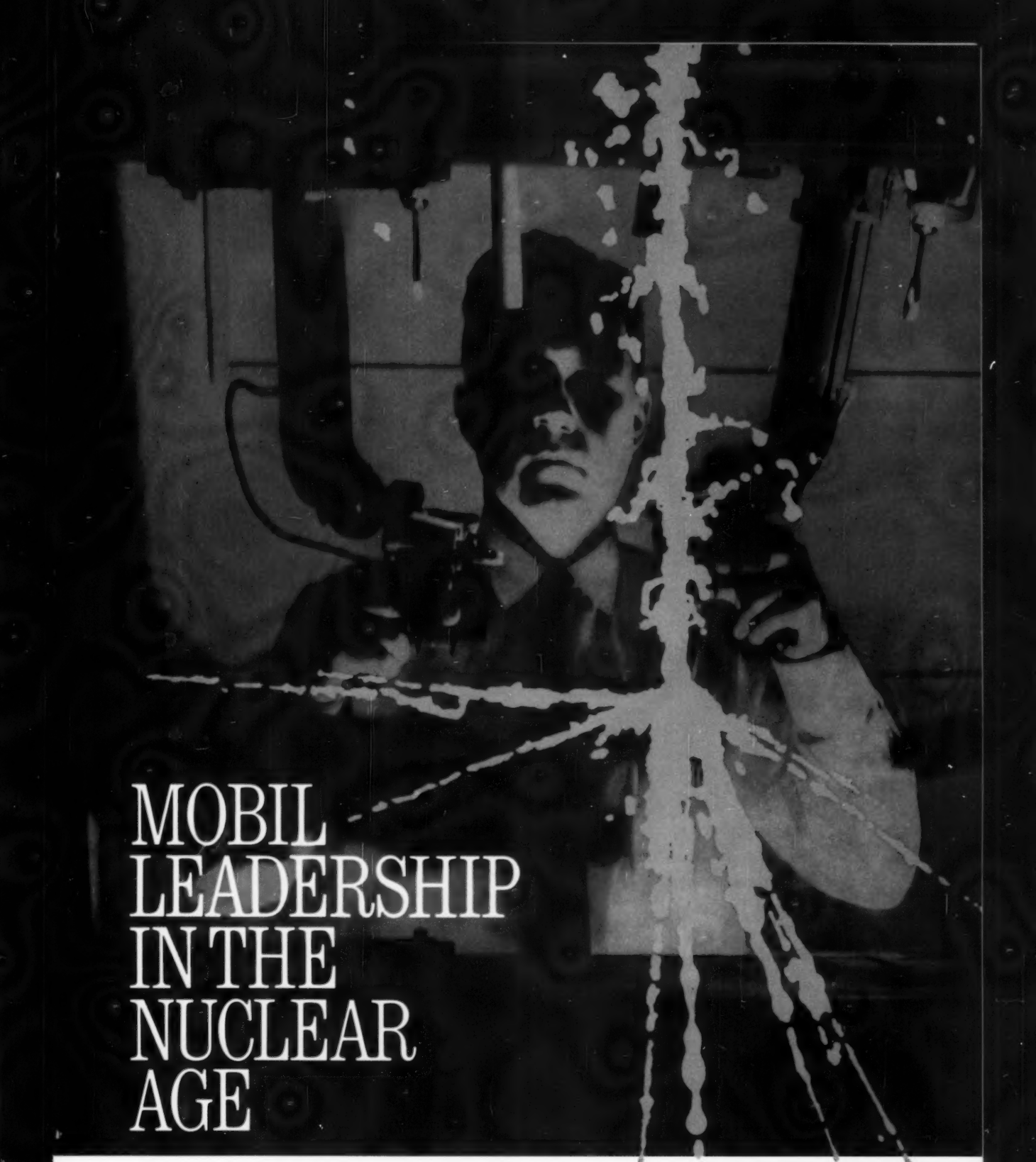


MOBIL LEADERSHIP IN THE NUCLEAR AGE

On the following pages, a report on Mobil's many activities in the field of Nuclear Radiation Research and what is being accomplished. How Mobil is meeting the challenge and problems posed by Nuclear Age Lubrication ... from America's leading protector of Nuclear-Powered Turbines.

Mobil

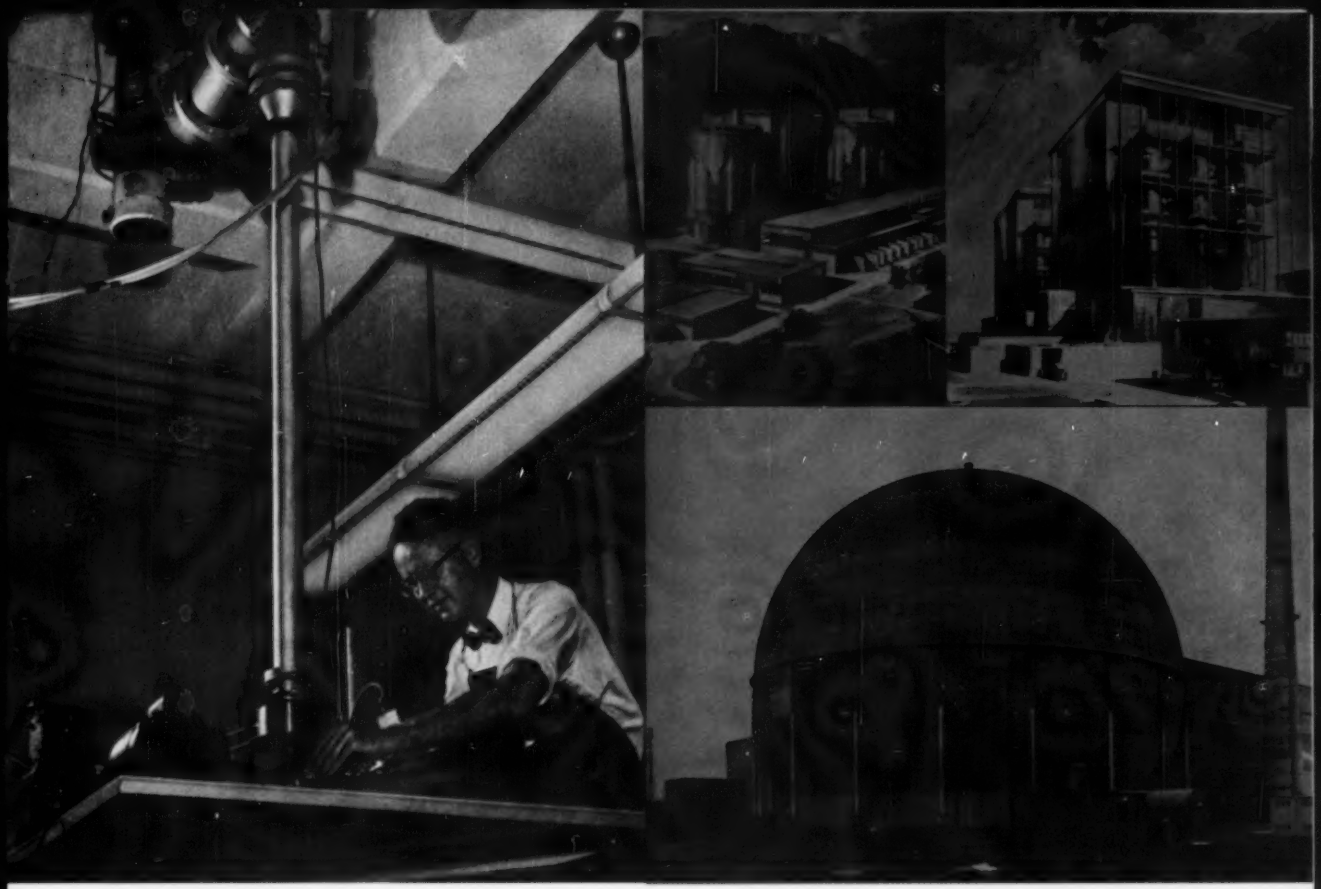
Mobil Leadership in the Nuclear Age

This unique dome-shaped structure houses the Industrial Reactor Laboratories Inc., where Mobil participates with companies from other areas of industry in nuclear research activities.

Mobil Nuclear Research

As a world leader in petroleum technology, Mobil is meeting the challenge of the Nuclear Age with facilities, programs and products. No one yet has all the answers. But Mobil Nuclear Research is opening many doors to future progress. For example, Mobil is part owner of one of the world's most advanced private nuclear research facilities, Industrial Reactor Laboratories in Plainsboro, N. J. Here a 5-million watt nuclear reactor is used to explore new refining techniques, the manufacture of petroleum chemicals, and effects of radiation on petroleum products. Mobil's own nuclear laboratory near Princeton, N. J. includes a 2-million electron volt particle accelerator and other advanced equipment to probe the atomic frontier. This research is yielding new knowledge, products and processes . . . and improved lubrication for Nuclear-Powered equipment.

View of 5-million watt swimming-pool-type reactor used by Mobil at IRL. Primary purpose is to provide source of neutron and gamma rays for experimentations. Mobil scientists use this radiation source to develop new petroleum products and chemicals.



2-million electron volt Van de Graaff accelerator at Mobil's Stony Brook Nuclear Laboratory is used to irradiate test specimens . . . help Mobil study effects of radiation on petroleum materials and find improved refining techniques.

Top-left: 360,000-kw Station being built at Hunterston, England. *Right:* 561,000-kw Atomic Power Station under construction at Hinkley Pt., England. *Below:* Dresden Nuclear Power Station in Illinois, now America's largest. All rely on Mobil.

Mobil Nuclear Lubrication

Through research, Mobil has determined the radiation limits of its present power plant lubricants, and is developing high threshold products for use where radiation exceeds these limits. These evaluations show Mobil DTE oils meet every requirement of today's Nuclear-Powered turbines. And certain Mobil extreme-pressure greases can withstand 200-million rads. In addition to these present-day lubricants Mobil has developed experimental products that resist doses of up to a billion rads, including a control-rod actuator grease approved by the United Kingdom Atomic Energy Authority. Mobil is also evaluating a method of determining condition of oil in use by adding a radiation-sensitive tracer that accurately shows when radiation limits are reached. These are some of the ways Mobil is preparing today for tomorrow's nuclear power needs.

Mobil Protected Nuclear Power Plants

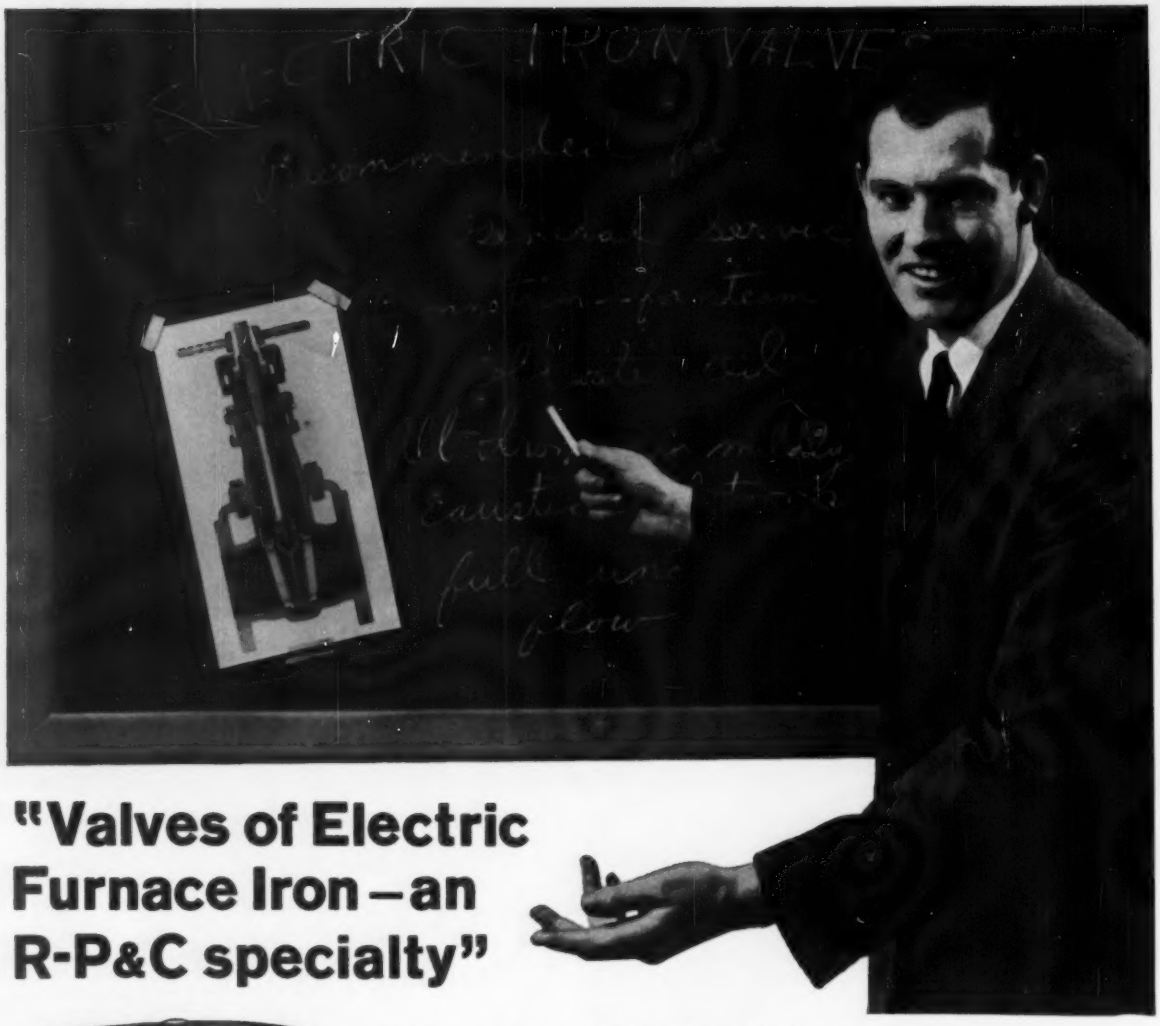
For years Mobil has been a world leader in the lubrication of conventionally powered turbines. Now in the Nuclear Age Mobil leadership continues. By early 1961 more than 60% of America's nuclear power output will be generated with the help of Mobil lubricants. America's largest atomic plant—the 180,000-kw Dresden Nuclear Power Station—protects its turbine with Mobil DTE oil. And even larger plants abroad will be Mobil protected. The 360,000-kw Hunterston plant and the 561,000-kw Hinkley Pt. plant under construction in England will both rely on Mobil. Mobil research and know-how are behind Mobil's continuing leadership in the Nuclear Age.

Hinkley Pt. Power Station—Built by English Electric Co., Ltd., Babcock and Wilcox Ltd., Taylor Woodrow Atomic Power Group for Central Electric Generating Board. **Hunterston Nuclear Power Station:** Builders—General Electric Company Limited of England for the South of Scotland Electricity Board. **Dresden Nuclear Power Station**—Built by General Electric Company for Commonwealth Edison Company and the Nuclear Power Group.

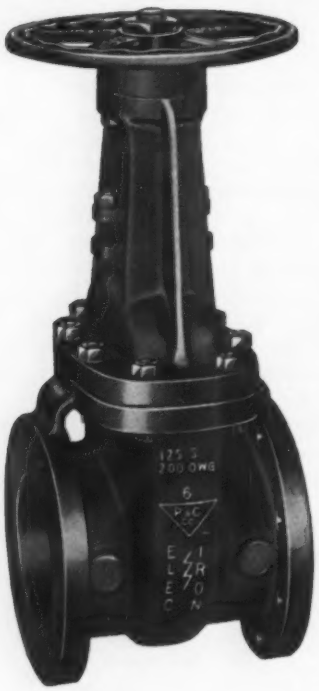
America's leading protector of Nuclear-Powered Turbines!

MOBIL OIL COMPANY, 150 East 42nd Street, New York 17, N.Y.

Mobil



"Valves of Electric Furnace Iron—an R-P&C specialty"



"Manufacturing castings from iron melted in our own electric furnaces and to our own specifications has long been an R-P&C specialty. Recognized for their superior quality, these castings of **highly refined metal** are substantially free of impurities. Dense grain structure gives them a high resistance to corrosion, high tensile and transverse strength, plus excellent deflection characteristics. In fact, their **physical properties far exceed** the standard requirements for iron valve castings. And all of these advantages are available to you in R-P&C Electric Furnace Iron Valves at no extra cost."

Shown here is an R-P&C Gate Valve of the flanged end type. It is available in sizes from 2" to 24" in bronze trim or all-iron construction. The R-P&C Iron Valve line includes other popular types of Gate, Globe, Angle and Swing Check Valves—all made of Electric Furnace Iron.

Contact your R-P&C distributor. He can supply you promptly with any Iron Valve you need as well as gate, globe, angle and check valves in bronze, cast steel and forged steel; all in a wide range of sizes, styles and pressure classes. See him or write...

R-P&C VALVES

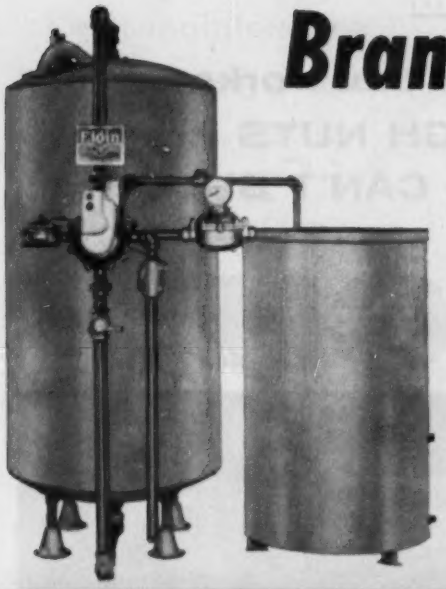
ACCO

R-P&C Valve Division, American Chain & Cable Company, Inc.

Reading, Pa., Atlanta, Boston, Chicago, Denver, Detroit, Houston, New York, Philadelphia, Pittsburgh, San Francisco, Bridgeport, Conn.

For more facts circle 316 on Reader Service card, p 103

Brand new AUTOMATIC WATER SOFTENER



Joins the Elgin Line ...at a new low, low price

This brand new Elgin Automatic Water Softener employs the Elgin time-proved multiport valve with simple, and therefore dependable, motorized lift-turn mechanism.

This simplicity of design not only gives it dependability of operation, but also permits selling it at a low, low price despite the fact that it is built to traditional Elgin quality standards.

Like all Elgin Water Softeners, this new automatic is also available in the revolutionary "Double-Check" design described below. Now more than ever before it will pay you to get a quotation from the Elgin man before you buy.

Available in Elgin "Double-Check" design

Yes, this new automatic—and the softeners with the two other controls described opposite—are available in the "Double-Check" design which gives these money-saving features:

1. Zeolite locked in . . . prevents costly replacements.
2. Being locked in, zeolite can be backwashed more thoroughly without loss . . . to keep softener clean, efficient, long lived.
3. Clean, receptive zeolite bed, plus highly efficient brine distributing system, means complete regeneration with marked salt savings.
4. Deeper zeolite bed of "Double-Check" softener gives far greater softening capacity from given size softener or equal capacity from smaller one.

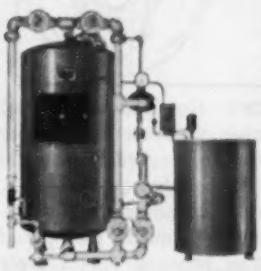
Ask for Bulletin 615

Complete facts about Elgin softeners and other equipment listed below are given in Bulletin 615. It is yours for the asking. So too are the services of the nearest Elgin representatives. They are listed in the yellow pages of phone books in principal cities under "Water Softening & Treatment."

Choice of two other outstanding controls

MANUAL MULTIPORT

Thousands of water softeners with the manual multiport valve control attest to its excellent performance and rugged construction. All operating steps are controlled by one simple revolution of valve handle.



HYDRAULIC ULTRAMATIC

For those who want the finest in automatic operation, this hydraulic "Ultramatic" is the answer. Its time-proved hydraulic valves and automatic pilot give the ultimate in dependability and control.

ELGIN
WATER CONDITIONING
SINCE 1908

ELGIN SOFTENER CORPORATION
130 N. Grove Avenue, Elgin, Illinois
Representatives in principal cities • In Canada: G. F. Sterne & Sons Ltd., Brantford

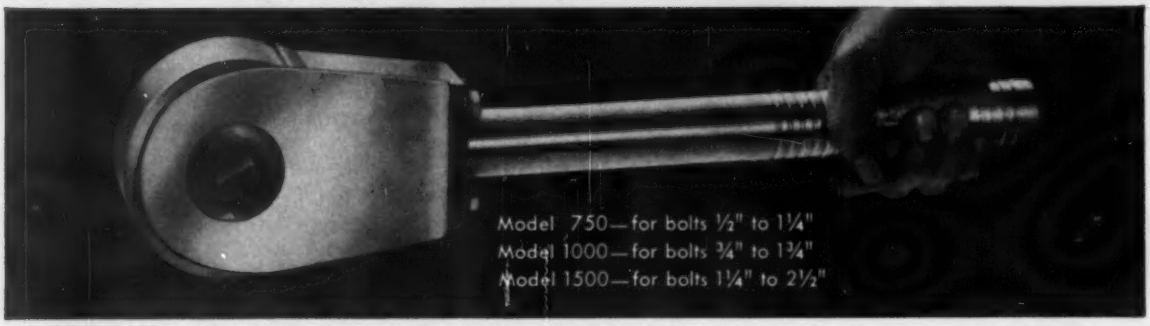
SOFTENERS | ION EXCHANGERS | FILTERS | DEIONIZERS | DEALKALIZERS | CLARIFIERS | DEGASITORS | DEAERATING HEATERS

For more facts circle 317 on Reader Service card, p 103

designed to solve a universal maintenance problem . . .

first manual impact wrench that works . . .
LOOSENS THE TOUGH NUTS
EVEN POWER WRENCHES CAN'T BUDGE!

SWENCH®



• Loosens "frozen" nuts in seconds • Tightens nuts to maximum practical tightness

There's never been anything like Swench before. It is an entirely new concept in wrench design. Swench is the world's *only manual impact wrench*. Here's what Swench means to you . . .

NEW SPEED—Nuts that previously had to be burned off can now be "Swenched off"—with unbelievable ease—by *one* man—in a matter of minutes.

NEW EASE—Only Swench in its torque class is truly portable . . . lets you take the wrench to the job—*anywhere*—with no auxiliary equipment, no power connections.

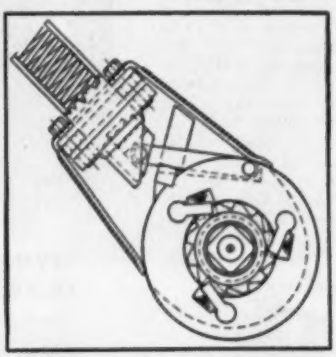
NEW SAFETY—With Swench there's no back-breaking, knuckle-knocking struggle . . . no dangerous handle extensions . . . no sudden release of a frozen nut . . . no shock transmitted through the handle.

NEW POWER—Swench, size for size, gives greater—and more effective—torque than power wrenches . . . multiplies torque applied to handle over 1500% (yet all Swench's power is built into the wrench itself).

NEW ECONOMY—Swench saves in *many* ways . . . no auxiliary equipment to maintain and man, no costly upkeep on the wrench, no man-hours fighting frozen nuts—*and* Swench costs less than half as much as wrenches with comparable impact power.

NEW VERSATILITY—*One* Swench can handle more bolt sizes than any power wrench . . . loosening or tightening requires no special adjustments.

NEW TENSIONING ACCURACY—Precise tightening is assured with Swench, following simple instructions.



INSIDE STORY—How is all this possible? Unlike power wrenches that deliver many tap-like blows, or ordinary manual wrenches that apply steady torque, Swench builds up power in its super-strong spring for a mighty wallop that is released as torsional impact every time the handle is advanced slightly more than 30 degrees.

Write for further information.

See for yourself! Swench is so different from anything you've experienced, you'll have to see it in action to believe it. For a quick and convincing demonstration, contact Marquette.

"When you're up against the tough nuts . . .
Don't wrench it . . . SWENCH it!"

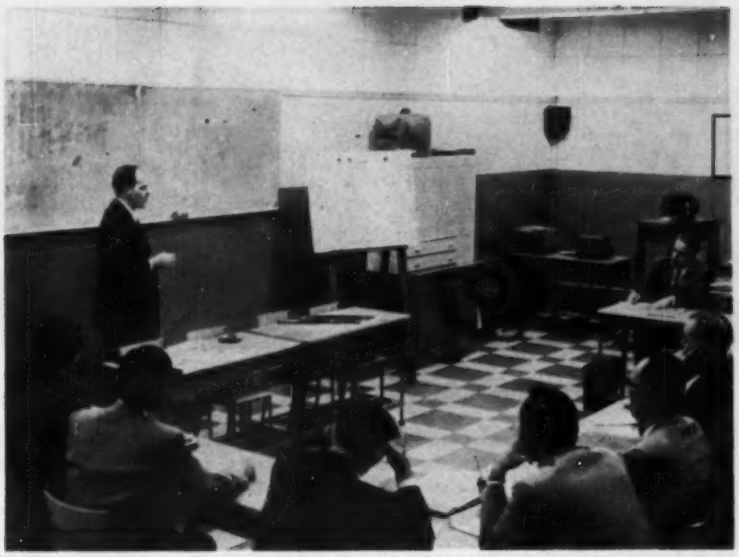
MARQUETTE DIVISION

CURTISS WRIGHT

CORPORATION • 1140 GALEWOOD DRIVE, CLEVELAND 10, OHIO

For more facts circle 318 on Reader Service card, p 103

STEVE ELONKA
Associate Editor in Charge



LECTURES BY TESTING EXPERTS supplied added knowledge-in-depth of equipment design, operating characteristics and precision-testing methods used by manufacturers

Here's another step in industry's training program as...

Plant-cycle analysis gets a boost at workshop

By L E STEWART
Associate Editor

In October 1959, POWER received a detailed report and formal announcement of the first Heat Cycle Analysis Workshop sponsored by Bailey Meter Co at their Cleveland, Ohio plant. This workshop was attended by plant test engineers, results engineers and operating supervisors. It was designed to foster interest in plant-performance monitoring and advance some new techniques for analyzing performance data from a plant thermal cycle.

As a dyed-in-the-wool results engineer, I found myself extremely interested in any course designed to shed some light on that "black art" of performance testing. I called Bailey Meter Company to find out more workshop details. Their answer was, "come see for yourself." So I packed my sliderule, Steam Tables and supply of correction factors and went to join the next scheduled group of Btu chasers for a 2-week workout.

What I saw was an entirely different type of industrial training course. I also saw an amazing potential for advanced training, swapping and purification of testing techniques and the nucleus of a cooperative program for continually developing new performance-monitoring techniques.

continued

Calculations proved new methods

Several days and most evenings were spent performing heat-balance calculations and trying out new cycle-analysis techniques. Test data used in calculations came from one course member's plant. In addition to "live data", synthetic data was generated by computer using a digital model of the plant thermal cycle. Computer-generated data did not include testing errors but did give a chance to check and evaluate system faults which could not be safely duplicated in plant

Panelists covered test programs

Top power engineers representing three utilities and two manufacturers dug into the practical problems of establishing accurate test procedures and continuing programs for plant-performance analysis. ASME Power Test Code measurement and calculation techniques got a thorough going over from the point of view of the operating company as well as the manufacturer. Workshop members left this session with many practical ideas for test programs in their systems.

Instrument and control manufacturers have been running training courses for years. First and foremost, these have been designed to train instrument engineers in maintenance and adjustment of the manufacturer's equipment. Occasionally a workshop tackled design and application of control systems. However, the Bailey course was genuinely different: analysis and testing techniques discussed did not necessarily involve use of the manufacturer's equipment. Original push for this workshop idea came from the Prime Movers Committee of Edison Electric Institute. Bailey Meter Co answered their call by creating the present course.

Workshop goals were first met by exposing our group of engineers to a barrage of heat-balance data and general plant-performance calculations. With the exception of a few warmup calculations all operating data came from a Phillip Sporn plant cycle—home base for one of the workshop members. Several data runs came from test series conducted at the Sporn plant. As "live data", these test runs included the unavoidable instrument and testing errors which tend to mask small system faults.

Remaining Sporn cycle data was generated by computer so that workshop members would have a chance to analyze a full range of system faults. Use of a computer to get raw test data represented an interesting turnabout. Success of this venture stems from instrument manufacturer's development of mathematical system models to assist control development. From the workshop aspect, computer-generated data was extremely useful. By modifying the mathematical model, computer programers could simulate fouled heaters, dirty turbine blades or loss of a turbine stage. In this manner workshop members were able to analyze faults and practice spotting trouble by test analysis.

Lecture sessions alternated with calculation periods. The first few lectures, delivered by the permanent staff assigned to the workshop, introduced some new calculation and analysis techniques derived from Professor J K Salisbury's cycle-gain concept. Analysis guides employing the gain concept were developed for each basic part of the turbine-heater cycle. We all were struck by the sensitivity of the technique to partial faults which normally are not identifiable by full-heat-rate tests.

This was no static presentation of methods, but more an airing of concepts among a group of peers. Some of the basic guides are well-proved techniques by now. Others were experimented with during the workshop and will probably change considerably before final acceptance. There are one or two as yet unexplored areas, and several of us left the course

Workshop checked computer programs

Computer sessions taught programing of performance calculations, including cycle analysis for troubleshooting. Engineers working in small groups were able to write computer programs and check them out at Case Institute's Computing Center. Workshop members interested in applying cycle analysis techniques through use of their own computers had a chance to become acquainted with problems of programing live data and get some expert advice from Case Engineers

Finally, methods applied in home plant

Final success of the workshop depends upon application of each engineer's knowledge to his own plant's problems. For most members, workshop sessions were just the beginning of a long process of adapting analysis techniques to varied cycles. After planning performance programs to be followed, plant test departments must evaluate instrumentation needs and modify test techniques to come up with greatest sensitivity in measured results. Only then is the course completed

determined to peg away at these areas in any way we could.

Guest lecturers from turbine, condenser, heater and boiler manufacturers covered equipment design and operating characteristics in great detail. This portion of the workshop was invaluable. In selecting lecturers, workshop leaders attempt to rotate companies represented. But each lecturer is selected primarily for his knowledge of subject, candidness in answering questions regardless of individual company viewpoints and his ability to speak and think clearly before a group. In our workshop sessions, guest speakers did a terrific job of educating-in-depth and their presentation of practical test hints rounded out the calculation-and-analysis picture.

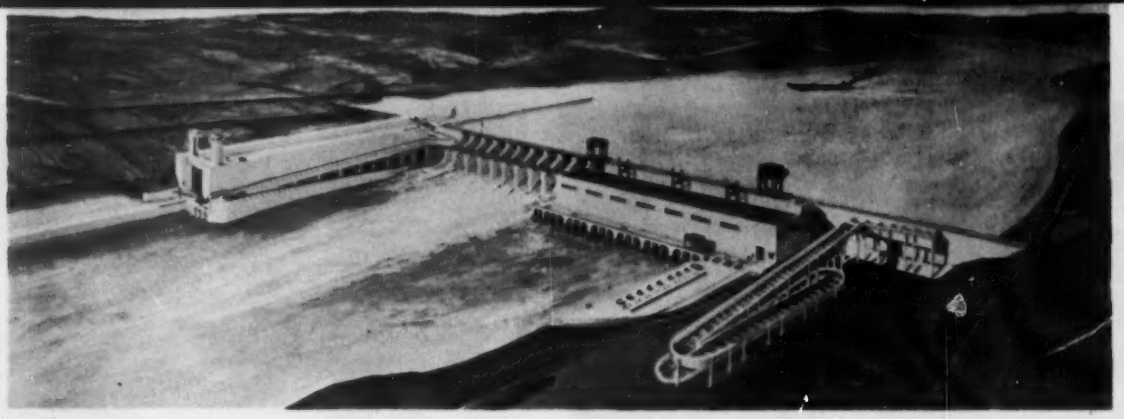
Panel members filled in yet another aspect of the workshop picture. Representing three utilities, one turbine and one condenser manufacturer, panelists discussed organization and operation of continuing test programs. In addition, the entire group dug into ASME Power Test Codes and their effect on the programs.

Computers for plant-performance monitoring seem to interest all results engineers today. So a final portion of the workshop dealt with automatic calculation of plant performance, equipment for automatic monitoring, programing techniques for computer calculations.

Case Institute Computing Center in Cleveland became the proving grounds for final classwork. Professor F Way III, assistant director of the computing center, spent many hours discussing general computer techniques. Then 3-man workshop groups tackled the problem of programing several performance calculations. In the evening these groups "proved" their programs by running them through a computer at Case, got valuable experience in how to apply these programs to their own computers.

Final use of all this knowledge now rests with the individual members of the workshop. With the formal course over, our group split up to go back to plants and start the actual application of analysis methods. This is no overnight affair; Bailey Meter Co engineers estimate six to eight months' time lag before knowledge of new techniques is converted to active programs.

Success of Bailey's workshop can be measured immediately in the enthusiastic response of engineers attending, in their increased awareness of advanced testing techniques and the ready exchange of methods and ideas. In the long-range view, these same engineers can spearhead the drive for greater precision in plant operation and maintenance by proving the worth of these concepts in their own plant performance monitoring.



FISH LADDERS along both shore lines let salmon and steelhead trout proceed to their natural spawning grounds. Flow down the ladders is not enough to attract fish to bottom rung; large pumps must recirculate tailwater to create optimum velocities

Fish-attraction pumps aid hydro growth

You can't change the habits of a fish. So a $10,000,000 facility at each hydroelectric dam protects the $20,000,000 salmon industry

By R H DEURER, Worthington Corporation

Hydroelectric expansion of the Pacific Northwest takes into account the Chinook-salmon and steelhead trout industries, and the habits of the fish themselves, who must travel to natural spawning grounds far upstream. These athletic fish take rapids, falls and natural obstacles in stride, but man-made dams are much too high for them to negotiate. Yet if the fish were barricaded away from their historic spawning grounds, the salmon and steelhead fish industry would soon die out—along with the fish. Until artificial-spawning-area research proves acceptable to them, the finicky fish must somehow be allowed to get to their natural spawning grounds under their own power or be transported there past man-made dams.

Fish tend to follow the river banks on their way upstream, so fish ladders are usually located on both sides of the river. The ladders are really pools in series with a 1-ft drop from pool to pool. Flow down the ladders creates small waterfalls, and over 1000 fish per hr swim up, a step at a time, on their way to spawn.

Fish's instinct makes them swim against the current. Backwater provides enough flow down the ladder to keep the fish moving, but doesn't build up necessary velocity at the bottom to attract fish to the ladders in the first place and start them up.

"Fish-attraction" pumps are the answer. Located at the bottom of each ladder, they create water velocity needed to attract the fish. Experiments show that carefully placed openings about six ft below tailwater level must emit 60 cfs at a velocity between four and eight fps to be most efficient. Water velocity of about two fps is required between the openings and ladder's bottom "rung" to attract the fish.

Large low-head pumps recirculate tailwater through the connecting basin and attraction openings to create this flow and velocity. Pumps are built like large vertical-condenser circulators, taking their suction from a wet pit supplied from tailwater and discharging into the connecting basin. They are usually of the "pull-out" type to facilitate maintenance. To give an idea of quantities of water to be pumped, on the Columbia-River system total capacity at the McNary Dam is 7500 cfs; at Ice Harbor, 3150 cfs. Total heads are usually about three to four ft. So these pumps are of necessity very low speed; motor-gear drives are common today.

Even though this is a relatively new pump application, trends are showing up in developing pumping equipment for fish attraction. Economics dictate that new installations go to fewer, larger pumps. Because of the physical size of components such as suction scoops and discharge elbows, these are now incorporated into the concrete structure itself. Then the pump consists only of impeller, diffuser and shaft sections—saving dollars.

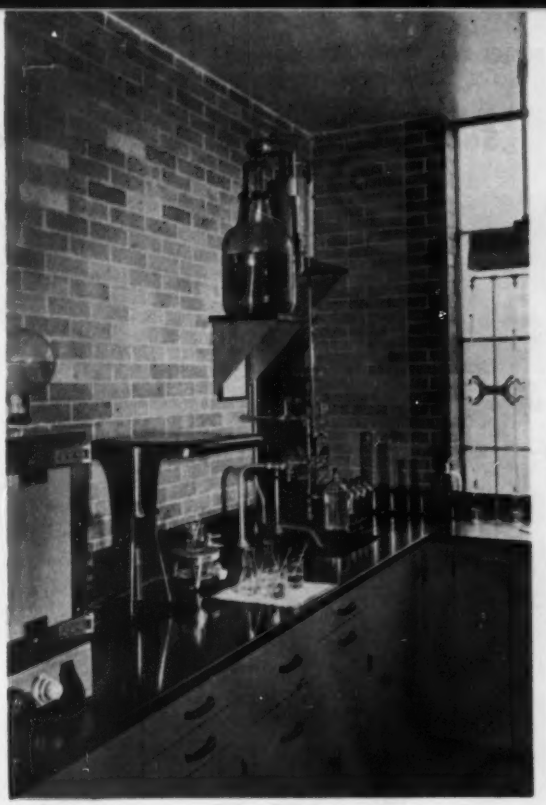
Hydraulic turbines are beginning to supplant motor-gear drivers. Variable-speed operation meets different tailwater levels, and discharge from driving turbines can be added to pump discharge to account for about 10% of the required attraction flow. Reducing number of pumping units needed by increasing their size permits installation right in the powerhouse instead of in a separate pump house—again for a dollar saving.

As pace steps up in developing the hydroelectric potential of the Pacific Northwest, experience in fish-ladder operation will undoubtedly produce better, less-expensive ways to insure continued supplies of fish to the important salmon and steelhead-trout industry—and to the sportsman who enjoys angling for them.

Too little testing leads to trouble; too much wastes effort and dollars. Only a close look at your plant will answer the question . . .

Is your boiler-water test program adequate?

By J C BOOSER, Chemist



MODERN boiler-water testing lab is equipped to handle all routine tests plus special ones to insure adequate water control

Boiler-water tests of some type are always required in steam generation. In large plants, tests are many and sometimes intricate; in a small plant a few simple checks may suffice. But no plant can get away without some sort of testing. Developing an adequate program—enough but not too much—requires a careful study of the plant cycle. Take into account pressures, temperatures, makeup quantity and quality, type of treatment and end use of steam—prime mover, process or heating.

Basic tests for almost all steam-generating plants include alkalinity, pH, NaCl, PO_4, sulfite and solids. These are needed on every boiler, from the small packaged unit on up to high-pressure central-station boilers. Numerous other tests meet specific needs—table on p 187 lists usual tests and procedures available.

Location and design of sampling points need your careful attention. Error here will nullify all other efforts at boiler-water control, producing results which may be erratic and misleading. Sampling points usually should be located at input and output of important equipment in the cycle —treatment-plant components, heaters, boiler and condensers. Diagrams on next page show sample-point locations for several typical cycles. Frequency of sampling varies widely; the number of samples and tests at any one point may have to go as high as ten if you're to be sure of dependable data.

Continuous recorded results are justified at important points; at other points a single daily test will do. Only a careful review of the cycle and its needs will tell how many and how frequent tests are needed. It might pay you to consider using continuous-recording meters. These handy instruments will also show up erratic operation which may not be revealed by periodic sample testing. Today, automatic chemical analyzers are available as supplements to the more common conductivity, pH, dissolved-O_2 and H_2 recorders.

In gathering samples you must be careful not to contaminate the water before testing; this might yield false results. Design of the sampling point must take into account type of sample and tests to be run. Here are some hints on sampling-point design and techniques, to reduce errors:

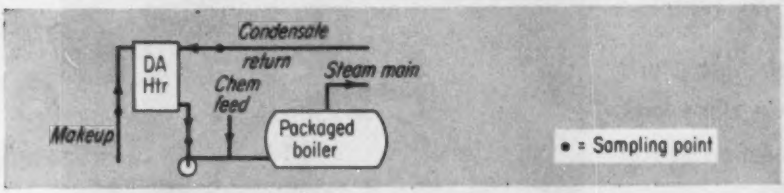
Water from tanks. Water quality may change at various depths in the tank. Take several samples at different depths.

Water from pipelines can usually be tapped with simple sampling connections except where water supplies combine or chemicals are introduced. Here sampling point must be far enough downstream to allow complete mixing before sample is taken.

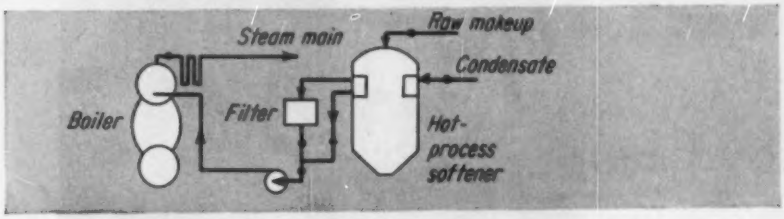
Water from boiler drums is usually sampled with a completely submerged perforated pipe extending the length of the drum. But be careful to avoid areas adjacent to feed inlet or chemical-injection lines. Cool samples to prevent flashing.

Steam samples are taken from superheater headers and steam mains, or less frequently from boiler drums and turbines. Perforated pipe takes samples from headers and boiler drums. Use standard ASME nozzles for mains, but be careful about location. A long vertical run with flow downward is best. Where you can't

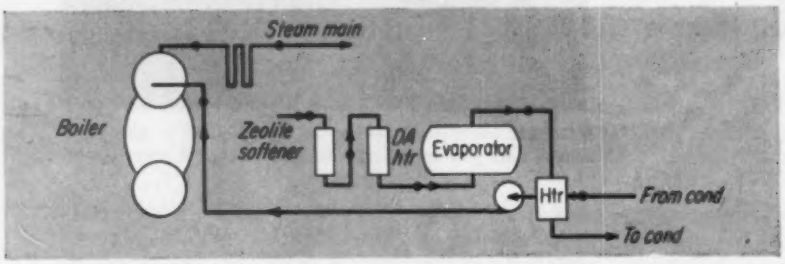
Sampling-point locations for typical cycles



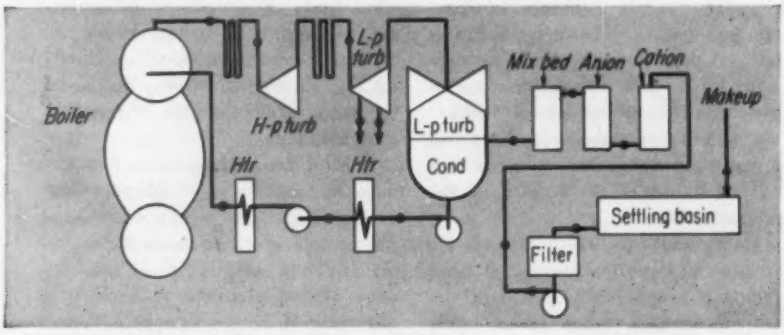
LOW-PRESSURE PACKAGED BOILER with minimum treatment



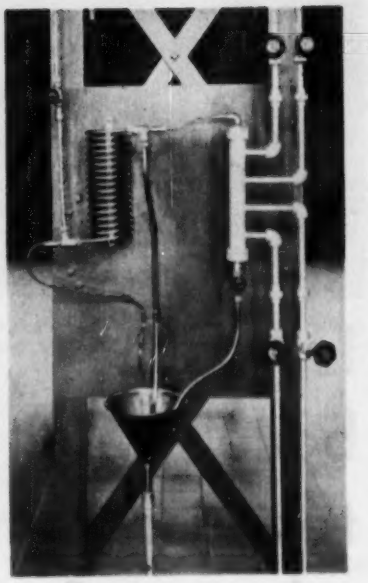
LOW-PRESSURE BOILER with hot-process softener



MEDIUM-PRESSURE BOILER with zeolite softener and evaporator



HIGH-PRESSURE BOILER with demineralizing plant



SAMPLING STATION with concentric cooling coil takes water from two boilers

avoid a horizontal run, try to insert nozzle vertically. In any case, keep nozzle as far as possible from bends, valves or other equipment affecting flow pattern.

Sample-cooling coils for steam sampling may take many forms. Some general rules hold: be sure cooling-water pressure is less than sample pressure, so leaky coil won't contaminate the sample. For conductivity tests, cooling alone is not enough; CO_2 and NH_3 contribute to conductance and must be eliminated. One method uses a boiling sample since CO_2 and NH_3 will not go into solution in the hot water. Another device provides atmospheric boiling, conductivity measurement, flow through an H+ ion resin, reboiling and another conductivity measurement.

Sample handling. All sample lines must be thoroughly flushed two to five min before sampling. Time varies depending on length of line, pressure, flow and sampling frequency. Use chemically resistant glass or plastic bottles—plastic for silica tests. Fill and rinse twice, then let bottle overflow long enough for three changes of water. Stopper immediately. Where air contamination would destroy test results, take sample underwater and stopper to avoid air bubbles. Test all samples as soon as possible.

In selecting tests to be run, be sure to cover your needs adequately. But don't overdo it. Tests cost money, and test results not needed or used in plant operation are a waste of dollars. Where several available methods will produce needed data, select method giving minimum required accuracy which can be run as quickly as possible at least cost. There's no point in running a test to get accuracies of 0.01 ppm if you control operation only to the nearest ten ppm.

Review your testing schedule regularly. Sometimes we add new test procedures as needed but fail to eliminate tests no longer used in plant operation. They continue to be run through sheer habit — and they continue to cost money. Check from time to time to cut the deadwood out of your program.

Your plant's optimum program includes some of these tests and procedures

Suspended solids

Gravimetric procedure must be used for quantitative analysis. But in many cases visual inspection and descriptive terms —*clear, hazy, cloudy, turbid*—are used

Soluble solids

Gravimetric test is most accurate but lengthy. Electrical-conductivity test gives quick, simple and reasonably dependable results. Periodic gravimetric tests establish factors for converting electric conductivity into ppm soluble solids

Total alkalinity

Titration test with standard acid uses methyl-orange indicator. End point is about 4.5 pH. Test measures alkaline hydroxides, carbonates, phosphates and silicates. But end point is vague unless titration is fast. Results: ppm $CaCO_3$

Phenolphthalein alkalinity

Titration test with standard acid using phenolphthalein indicator gives sharp end point at about 8.3 pH. Measures all hydrates and half of the carbonates. Results: ppm $CaCO_3$

Hydroxide alkalinity

Two titrametric methods are available. Simplest, using barium chloride, is accurate to 10%. Strontium-chloride method is accurate to about 2% but lengthy. Results: ppm $CaCO_3$

pH

Colorimetric tests are accurate to about 0.1 pH. Electrometric methods using glass-electrode assemblies with meter are more sensitive and accurate. However, faults with apparatus not readily discernible can introduce sizable errors. pH values can be continuously recorded

Chloride

Two titrametric methods here: Mohr's method uses silver nitrate with potassium chromate indicator—reasonably accurate for normal-chloride-content waters. For low-chloride waters, more-sensitive mercury-nitrate test is preferred. Results: ppm NaCl

Hardness

Versenate or EDTA titrametric method is extremely sensitive, accurate, relatively simple. Results: ppm $CaCO_3$

Sodium sulfate

Gravimetric, photometric and titrametric methods. Gravimetric procedure is too time-consuming for routine work and photometric tests are not accurate enough. Titrametric method using benzidine is sufficiently accurate for general use and reasonably fast. Results: ppm Na_2SO_4

Sodium nitrate

Colorimetric method uses either color comparator or electrophotometer. Results: ppm $NaNO_3$

Sodium sulfite

One titrametric method uses N/40 iodine and N/40 sodium thiosulfate. Preferable method uses standard potassium iodate; a modification is available for low-sodium-sulfite values of about 0 to 5 ppm. Results: ppm Na_2SO_3

Phosphate

Various color-comparison methods use special color apparatus or an electrophotometer. Color comparators are relatively inexpensive, accurate, simple to use; test is rapid and generally accepted. Results: ppm PO_4

Silica

Several colorimetric methods to choose from (gravimetric tests are too lengthy). Nessler tubes, color comparators or electrophotometers can all measure color intensity. Silicomolybdate color test is most widely accepted and rapid, but requires careful technique. Results: ppm SiO_2

Dissolved oxygen

Schwartz-Gurney modification of Winkler procedure is accepted method. Test demands considerable technical skill and is quite lengthy, with special equipment required. Indigo-carmine colorimetric method is new development. Short and simple to run, it's limited to range of 0 to 50 ppm dissolved O_2. Results: ppm O_2

Carbon dioxide

Several titrametric methods are accurate only if CO_2 is the sole acidic constituent present. All are reasonably simple but require careful handling to get dependable results. Results: ppm CO_2

Ammonia

Direct nesslerization and measurement of developed color intensity in a colorimeter is rapid and accurate but dependable only on unbuffered water. Results: ppm NH_3

Hydrogen

Test of gas thermal conductivity is basic method. Results measure decomposition of steam in high-pressure boilers but require considerable skill to evaluate. Results: ppm H_2

Steam and vapor purity

Gravimetric tests, throttling calorimeter readings, electrical-conductivity measurements and tracer techniques are all available. Conductivity measurements are most common but specialized sampling apparatus is needed and sensitivity is limited at high purities. For steam purities of 1.0-ppm-max solids this procedure is satisfactory. More precise results need sodium-tracer techniques. If sodium salts predominate in the boiler water, flame photometer tests will detect sodium down to 0.0002 ppm. This method is confined to limited spot-checking in most cases but can be continuously recorded

Hydrazine

Colorimetric tests use comparator or electrophotometer. Special sampling technique is involved, test is lengthy. Results: ppm hydrazine

Morpholine

Colorimetric method, a lengthy test using electrophotometer, requires technical skill. Results: ppm morpholine

Iron

A colorimetric method using ortho-phenanthroline and an electrophotometer is current procedure. Results: ppm Fe

Copper

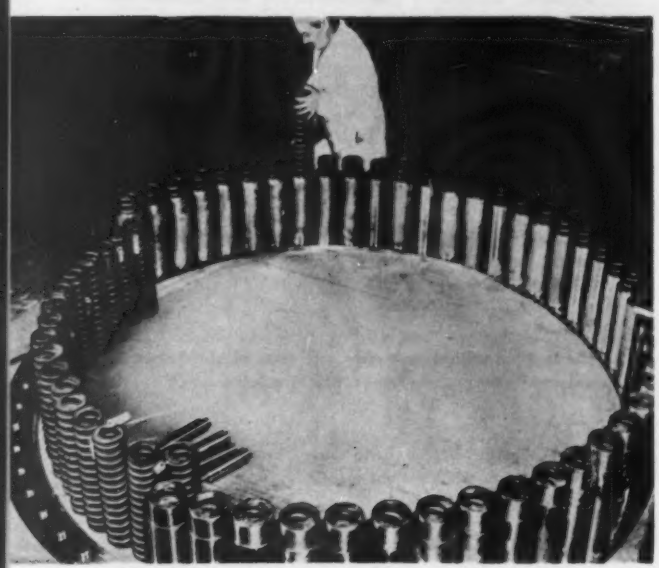
Several colorimetric methods here. Diethanolamine and carbonate test both require electrophotometer and skilled technique; a calibration curve must be prepared. Results: ppm Cu

OPERATORS' NOTEBOOK **141**

By STEVE ELONKA, Associate Editor

Nickel-base alloys: where and how to use them

INCONEL NICKEL-CHROMIUM alloy tubing inside a copper tube stands up to 625-F boiler-water sample, thermal shock, corrosion



INCONEL "X" springs support core of nuclear reactor. As 600-F water flows around them, they fight stress-corrosion cracking

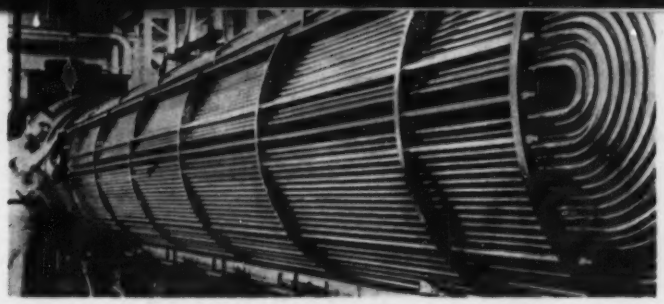
Nickel-base alloys fight rust, corrosion, chemical and electrolytic attacks. They perform well at high temperatures and pressures and they are tough. Here are six high-nickel alloys you should know about, plus info on how to apply them.

Monel nickel-copper alloy is used for pump shafts and rods, valve trim, gaskets—to lick corrosion, pitting, wear or corrosion fatigue. In feedwater heaters, Monel tubing handles steam above 800 F, 3000 psi.

Machining. High strength and ductility of Monel and other nickel-base alloys require a slightly different machining technique. Use only high-speed tools or tools of high-red hardness such as cemented carbide, ground to proper angles and with sharp cutting edges. Use plenty of cutting compound—sulfurized oils are best for finish machining. Use moderate speeds and feeds.

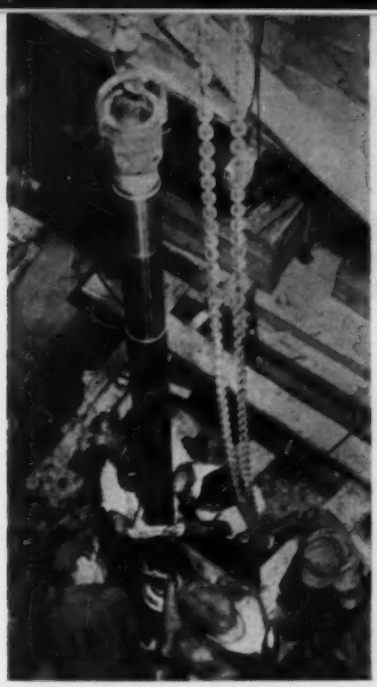
Welding. Monel and all the high-nickel alloys are easily welded. While techniques are similar to those for steel, high-nickel weld metal doesn't spread as does weld metal of mild steel. Using the metal-arc process, 130 Monel welding electrode suits all forms of wrought and cast Monel. Apart from normal flux and slag removal, no post-treatment is needed to maintain the corrosion resistance. In oxyacetylene welding use bottled acetylene; generator acetylene isn't recommended. For the best welds, use a slightly reducing instead of an oxidizing flame. Monel 40 gas-welding wire and Inco 3 gas-welding flux provide a strong, corrosion-resistant weld.

Monel alloy and other nickel-base alloys can also be welded with metal and tungsten inert-gas methods. Use 60-series filler wire and rods. While the 60 series is for joining nickel alloys to themselves, the inert-gas consumable-electrode process may be used with 60-series filler wires for sound, ductile overlays. Monel alloy mill forms include castings, angles, plates, rods and bars,



MONEL ALLOY tube bundle is for spherical-head heater. Bundle is 30-ft long, 40 in. in dia. It handles 3000-psi pressure with bleed steam at 850 F

"S" MONEL comes only in cast form. This large pump impeller is 84 in. in dia, handles highly corrosive, brackish sea water at a rate of 120,000 gpm



"K" MONEL shaft, 28-ft long, has rubber bearings, handles condenser cooling water

tubing, sheet, strip and wire and a myriad of other shapes.

"K" Monel alloy is an age-hardenable nickel-copper alloy. One advantage: you can heat-treat it for high strength and hardness after finishing. Hot-rolled "K" Monel with 100,000-psi tensile strength is soft enough for forming or machining. Then it can be heat-treated at 1000 to 1100 F for high hardness, raising tensile strength of the alloy to 150,000 psi.

Alloys of "K" Monel have corrosion resistance of regular Monel alloy. Example is a 1½-ton "K" Monel circulating pump shaft, above. It handles corrosive sea water and industrial wastes. "K" has wide use in valve parts and boiler-feed pumps. It's best machined in annealed condition, using same high-speed tools.

"S" Monel nickel-copper alloy comes in cast form, has same corrosion resistance as cast Monel. But it's much stronger, harder and more resistant to galling. One giant pump impeller made of "S" Monel was installed to handle highly corrosive, brackish sea water for producing electric power in a chemical plant. "S" Monel alloy is also good for pump sleeves, valve trim and pump liners. Castings can be machined in the as-cast condition, same as Monel. For extensive machining, castings may be annealed, hardened afterwards. Don't use these castings for fabrication welding.

Inconel nickel-chromium alloy withstands high temperatures, shows good corrosion resistance. It's resistant to progressive oxidation (up to 2200 F), fatigue and stress-corrosion cracking.

Inconel alloy was used for sampling coils to handle steam temperatures of 650 F, top left. Stress-corrosion-cracking, thermal-shock and corrosive-attack problems were solved. Despite its great strength it's ductile, easily formed into the coil-within-a-coil arrangement.

This alloy is widely used for springs that must operate up to 700 F. It machines best when annealed. It's tough and strong; again high-speed tools are best. Use sulfur-base oils as cutting compound, and remove the compound before welding or exposing to high temperatures.

For metal-arc welding, 132 Inconel welding electrode suits all forms of wrought and cast Inconel alloy. For oxyacetylene welding, use 42 Inconel gas-welding wire. Metal and tungsten inert-gas method can also be used. Mill forms come in rods and bars, plate, sheet and strip, tubing, wire and castings.

Inconel "X" age-hardenable nickel-chromium alloy can be heat-treated to develop high creep-rupture strength and relaxation resistance. Latter quality is desirable for springs at high temperature under corrosive conditions. For example, 13,000 tons per hr of water at 500 to 600 F flow around springs used to support core structure of a nuclear reactor. Inconel "X" alloy prevents stress-corrosion cracking and embrittlement here. This alloy is also used for gas-turbine rotor blades. Its high creep and rupture strength and its structural stability insure long life. It machines as well as Inconel alloy. You can metal-arc-weld with 139 Inconel "X" Electrode, but don't oxyacetylene weld. Mill forms include forging stock, rolled rounds and flats, wire, plate, sheet, strip and tubing.

Incoloy nickel-iron-chromium alloy is used for jobs that must resist oxidation and other types of high-temperature corrosive attack. It has excellent hot strength —up to 1850 F—and good resistance to embrittlement. One new use is boiler ash-pit drip lips where heat and slag erosion are problems.

Incoloy alloy is formed and machined like nickel alloys. It can be welded and even joined to dissimilar materials with Inco-Weld "A" electrode or filler wire.

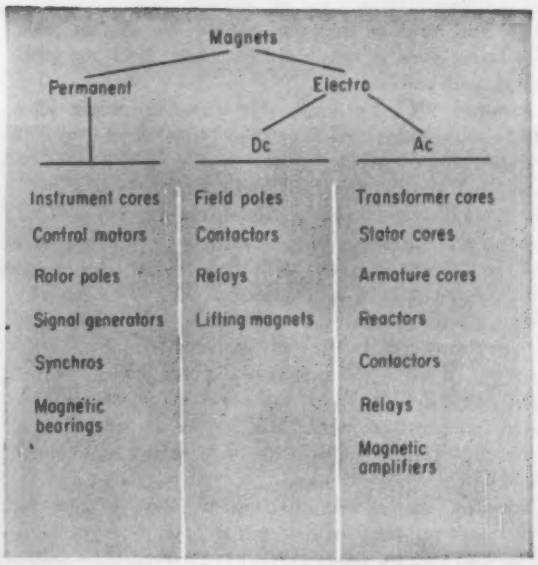
Plant
Electrical
Fact File

NO. 49: MAGNETS

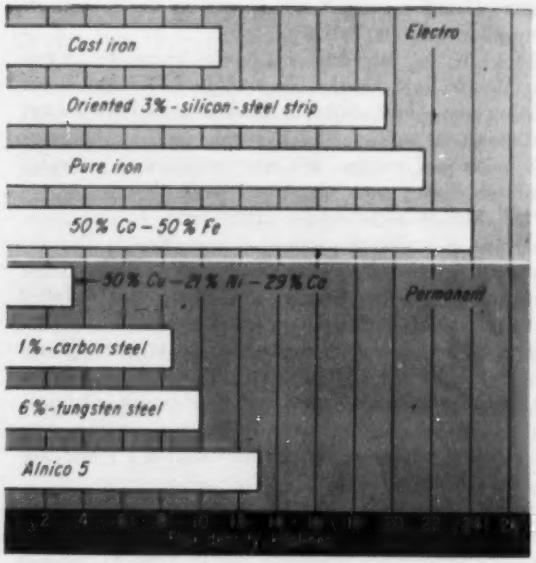
Most electric machines make use of magnets in some form. Generators, transformers and motors have magnetic cores as essential parts. These *electromagnets* usually employ laminated sheet steel. Magnetic circuits of a dc field often are partly of cast iron or steel. Permanent magnets may be iron or steel, but are more likely to be one of several alloys, below, having much better properties. Small cores for instruments and static control devices may be made from powdered magnetic materials which are bonded together with a ceramic or plastic substance, then cast, pressed or machined to proper shape.

By NORMAN PEACH, Associate Editor

Magnetic materials: modern marvels

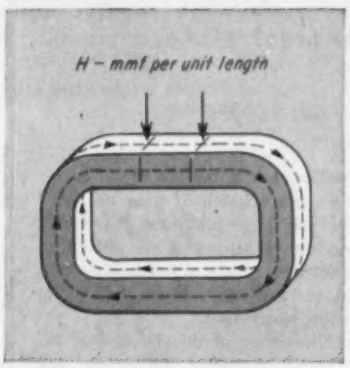


TWO BASIC TYPES are electromagnets and permanent magnets. Electromagnets are energized by current-carrying coils to produce mmf. When current shuts off they lose most of their magnetism. Permanent magnets, once magnetized, supply their own mmf. Under favorable conditions they will retain their magnetism indefinitely

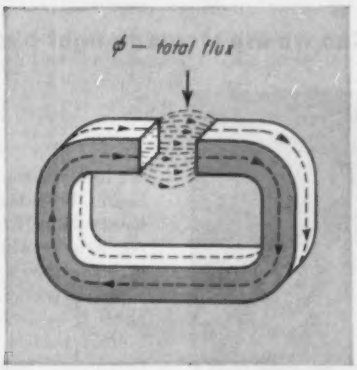


MAXIMUM FLUX DENSITIES practical with typical materials are shown (electromagnets at saturation, permanent magnets at residual induction). Important factor with permanent magnets is ability to resist demagnetization. It's expressed as *coercive force*, H_c. Magnets with highest coercive force don't have the greatest residual induction

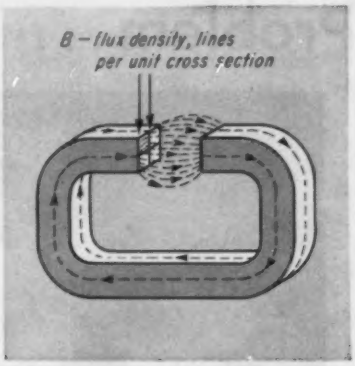
Three fundamentals of magnetic circuits



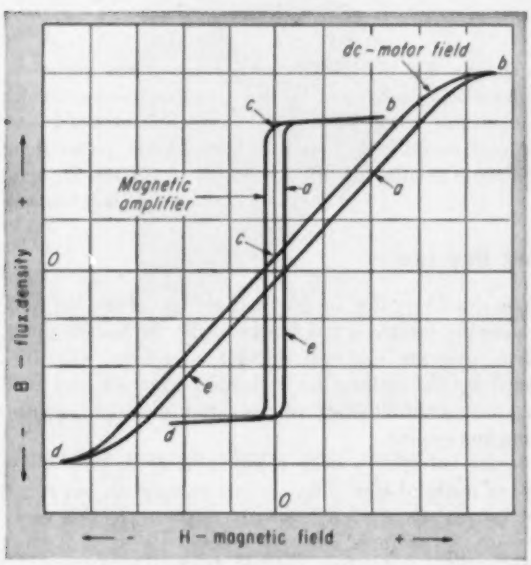
MAGNETIZING FORCE, *H*, is magneto-motive force (mmf) per unit length of magnetic circuit. Mmf, in amp-turns, corresponds to volts



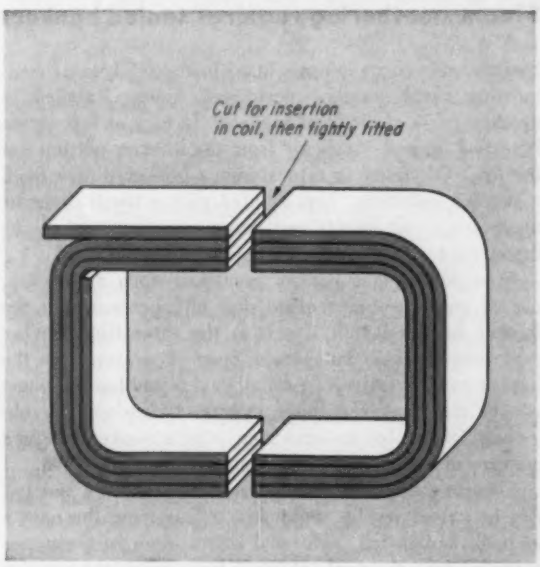
FLUX, ϕ, represents total magnetism. We assume that flux is composed of lines of force which "flow"; it is analogous to a current of electricity



FLUX DENSITY, *B*, is flux per unit cross section of circuit. The *B* produced by a given *H* is a measure of the magnetic material's *permeability*



HYSTERESIS LOOP varies with different materials. Starting unmagnetized, *B* and *H* increase together along curve between *a* and *c* to point *b*. Then when *H* reduces, *B* follows curve *a*, but at zero *H* (point *c*) *B* retains some value. *H* must now increase in opposite polarity to bring *B* to zero. The situation is reversed for curve *d-e-b*



ORIENTED CORES for electromagnets such as transformers and magnetic amplifiers have steel crystals aligned in consistent pattern. This increases permeability, reduces losses. Oriented cores are usually wound continuously, pressed and annealed. Then they may be cut in order to insert coils, after which pieces are tightly clamped

These **plant problems** could well be yours...

Problem . . . Can we use steam to fight bunker fires?

We have a 700-ton coal bunker at the top of our boiler house. Periodically we get a batch of poor coal and have a bunker fire. It has been suggested that we fit the bunker with perforated pipe and use steam to extinguish these bunker fires or use a steam hose with a pipe extension to lance into the coal fire and extinguish it by local steam blanketing.

Have readers any knowledge of this method of extinguishing bunker fires? I would appreciate any information that they can furnish on the use of steam in bunker-fire fighting.—*MGK, April* POWER

Solutions . . .

Steam smothering requires sealed bunkers

Steam-smothering piping is fitted in the bunkers of coal-burning naval vessels — perforated piping installed in upper corners of the bunker space. In case of fire, steam is turned on and expels air from the bunker, putting out the fire. Of course, a typical ship's bunker differs from a shore installation. Top is fitted with a hatch cover or manholes, to all intents and purposes a tight seal allowing steam to displace the air and smother the fire.

As a power-plant bunker usually is open at the top, use of steam would require that all openings into the bunker be fitted with doors, at the same time leaving explosion hatches that would open if pressure in the bunker rose excessively. And all coal would have to come out of the bunker without manual trimming—it's obviously impossible to send men into a bunker where a mixture of steam and carbon monoxide would exist.

Assuming that *MGK's* bunker is self-trimming and top can be closed up, he could take a leaf from the navy's logbook and install perforated steam pipes in the upper corners under the roof. When a fire occurs, the top can be closed, steam turned on until a slight pressure builds up in the bunker (measure it with a draft gage) and the steam adjusted to maintain this pressure. Then all he has to do is burn up the coal, or if coal is not being used, wait for the fire to go out from lack of oxygen.

Steam lances to put out local hot spots sound highly dangerous due to difficulty of getting to the hot spots without being suffocated by steam and carbon monoxide. Danger also exists that direct injection of hot steam into the coal would heat it up and help the fire rather than produce a smothering effect required to put the fire out.

J L AIKMAN, *Montreal, Que., Canada*

Try dry ice

MGK should try dry ice for fire fighting. If the hot spot is near the surface, a few blocks of dry ice buried about 12 in. over the spot will smother most fires. CO_2 liberated by the melting ice is heavier than air and will seep downward into the coal. Its action is twofold, smothering and cooling.

If the hot spot is deep it can usually be located by probes made of iron rods. In our experience, hot spots are usually about 15-ft below the surface. In this case, prepare two or three 3-in. pipes about 10- or 12-ft long with one end swaged to a point. Drill $\frac{3}{8}$-in. holes near the point and drive pipes into the coal pile until points are a few ft above the hot spot. Then fill pipes with dry ice and cap or plug them. Melting dry ice liberates CO_2 and forces the gas into the pile. This point source for application of smothering and cooling action may require placing probes in a specific pattern around fire.

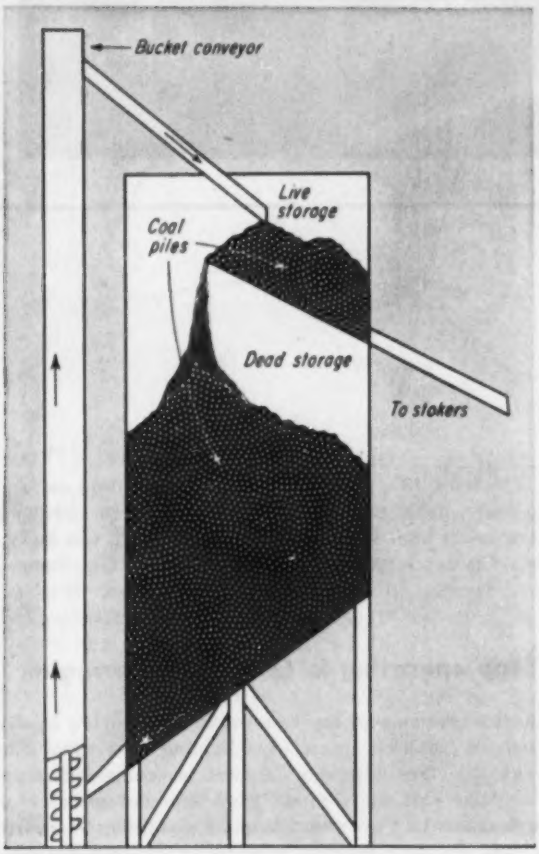
...Here's how Power readers would tackle them

LAWSON STEWART, Associate Editor

As soon as the dry ice melts, refill the pipes and keep repeating this cycle until the fire is out. Caution should be used when removing the cap; CO_2 gas may be under sufficient pressure to blow the cap off.

I've frequently had to tackle stubborn fires in storage piles of 25,000 tons. About 500 lb of dry ice always did the trick for me.

A R EASTCOTT, *Giscome, B.C., Canada*



Hopper design stops coal fires

We're sure that the reader with coal-heating troubles will be deluged with good ideas on how best to combat his problem, yet here is one we feel is a bit unique.

We've designed a special bunker, sketch above. Our bunker has a capacity of four cars of –2-in. mine-run coal which feeds by gravity to a stoker-fired boiler, providing steam for concrete curing. Bunker was arranged as indicated to overcome any tendency to reach a temperature above 170 F—beyond that value you can expect to have a smoky fire on your hands within 70 to 75 hr.

Note that a shelf has been provided in the bunker (silo) to separate approximately half a carload of space, above shelf, as the "ready" or live storage area which furnishes coal fed out by a spout into the stokers.

We dump into the bunker by endless-chain bucket conveyor. A short spout directs fuel into the ready space first; additional coal fills up the balance of the bin or dead storage space. As coal is needed, it's drawn off the bottom of this storage through a chute above the conveyor and hoisted to shelf storage for continued firing. By this arrangement some of the weight is removed from the dead storage; long waiting in dead storage is reduced. Arrangement allows coal movement at all times to overcome any tendency to get too hot.

EMIL CROSS, *Oak Ridge, Tenn.*

Fighting cause costs less than fighting fire

Using steam in the main portion of a 700-ton bunker to fight bunker fires is likely to create more problems than it will solve. It's possible to flood the existing hot coal with steam but this is hardly desirable in every case. Steam condensed on the cooler coal from overhead could result in a steam explosion when water reaches the burning coal in a deep hot spot.

Blanketing the coal with CO_2 in the form of dry ice will greatly reduce further burning if all openings are sealed as much as practical. Isolated zones may be more effectively cooled by placing dry ice underneath the surface of the coal. Getting your ice into best position will be the main problem here.

Along with fire-fighting techniques, operators should plan fire prevention. *MGK* may greatly reduce incidence of fires by seeing that these precautions are observed:

(1) Regularly clean out the bunker completely (perhaps at 6- to 12-week intervals). Vibrators or stainless-steel plates will do yeoman duty in problem areas where coal tends to hang or arch. (2) Load bunker evenly—consider distribution plates. (3) Reduce incoming coal to storage to a consistency minimizing segregation, thereby reducing air circulation through the bunker. A poor batch of coal is more likely related to sizing than fuel qualities as far as bunker-storage problems are concerned. (4) Coal containing a large percentage of fines should not be stored long. Use washed, double-screened coal for emergency storage.

(5) Avoid all sources of external heat such as hot lines against the bunker walls. (6) Keep gates and valves in lower portion of bunker in good repair. (7) Don't mix fresh and previously stored coal for long periods.

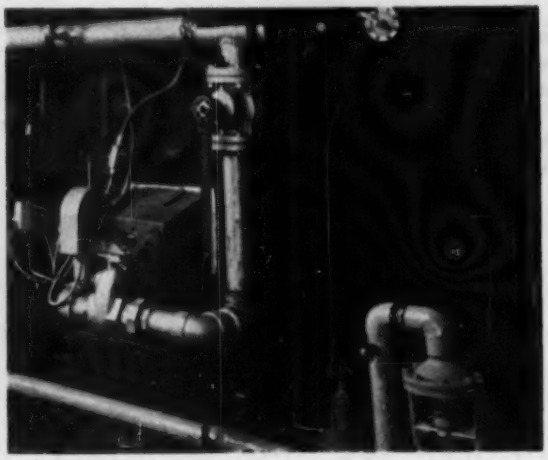
M L MYERS, *Concord, Tenn.*

Problem . . .

What causes burner pulsation?

We operate seven small refractory kilns for firing small batch orders or test runs. All kilns are equipped with air-aspirating gas burners with air supplied by one fan through a header duct. There are no dampers in air system; air to each burner is controlled by a valve in each burner assembly.

Our problem occurs when lighting off one kiln with the remaining six out of service. Gas flame pulsates and sometimes goes out. We would like to know how to prevent these pulsations. Can anyone help us?—*EFL, April* POWER



Solutions . . .

Bleed air through idle burners

In *EFL's* case I believe the troublesome pulsations are caused by too much air to one burner. There are several ways he can prevent these pulsations:

(1) If possible, install a governing device on the unit driving the fan. It's true that governors are expensive and they do require some attention and maintenance. But they may pay for themselves over a period of time because of the saving in horsepower. This would depend on percentage of time spent firing one kiln.

(2) If fan is driven by an electric motor, speed control can be achieved by adding a reduction unit between the fan and drive. Speed-reduction units take several forms depending on fan size and speed. As with the governor, cost and increased maintenance of the reduction unit should be weighed against savings.

(3) Install an orifice or damper somewhere in the header just ahead of the burner—or maybe in burner itself. Trial and error determines the correct size orifice for the particular job.

(4) It's quite easy to design and install an air leak-off somewhere in the header to boost fan air flow above the turbulent range.

(5) Try partially covering the fan intake with pieces of tin or similar material, varying the sizes until you find the proper size to use. Finally, construct a removable fan intake blank to match the shape found by trial.

Methods (3), (4) and (5) are poor substitutes and a waste of fan horsepower. I would use them only as a last resort after I had satisfied myself that it was impossible or impracticable to apply some sort of fan or motor speed control.

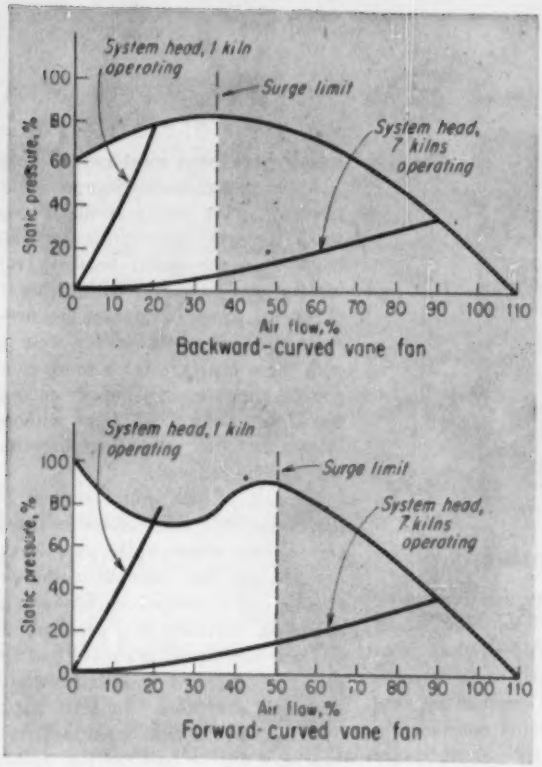
T E BURDETTE, *East Chicago, Ind.*

Stop operating in fan's unstable region

As a single fan supplies the seven kilns through a header and the pulsation occurs when lighting off a single kiln with the other kilns down, it can be assumed that the fan supplying the aspirating air becomes unstable at low capacity. Fans running under conditions of nearly closed discharge build up pressure in the discharge duct to a point where the air spills backward through the fan blades, creating turbulence in the case and causing rapidly fluctuating pressure in the discharge duct.

Try opening the air supply to two or three burners before lighting off the one that is to be used. If air cannot be put into the other kilns while they are cold, install a bleed valve on the air header into the kiln room to allow some air to spill out of the header. This will increase amount of air flowing through the fan sufficiently to put it into a stable operating range.

J L AIKMAN, *Montreal, Que., Canada*



Check fan capacity

Characteristic curves for most fans indicate a limited range of stable operation. At a given speed there is a minimum capacity below which fan operation becomes unstable—value ranges between 30 and 50% of maximum fan capacity. This phenomenon is frequently accompanied by a noise referred to as "surging."

When fan discharge rate is less than the surge limit, pressure in the discharge duct is greater than that generated by the fan. This causes momentary reverse flow —pulsations. Upon further reduction of fan capacity, duct pressure decreases and the fan again discharges into the duct. Surges from this source can be heavy.

EFL does not indicate type and size of his fan. Usually backward-curved blades offer a greater range of stable flow than fans having forward-curved vanes. Graphs above show these relations for the two basic vane designs.

Since only one fan is installed, it must satisfy air requirements for seven kilns operating concurrently. With one unit in service, air flow is approximately 14% of maximum. This may necessitate operating below the surge limit if air ratio is maintained.

I recommend that *EFL* review the pressure-capacity characteristic curve for his fan. By plotting a system-head curve for 1-kiln operation, he can determine if the operating range is within the stable zone. If it's not, there are two ways for EFL to tackle his fan problem:

(1) Install a bypass. Although this arrangement requires more power, it does allow pumping air quantity to permit operation without going below the surge limit.

(2) Introduce additional resistance into the system. This may be obtained by throttling the inlet of the fan.

H B WAYNE, *Woodhaven, N. Y.*

Your July problems

Why does our turbine hunt?

We have a 10,000-kw noncondensing extraction turbine-generator in our power plant. Throttle conditions are 450 psig and 600 F. Turbine exhausts to process line at 15 psig. Extraction steam flows to two large shell-and-tube heaters at 130 psig. Total extraction flow runs about 30,000 lb per hr.

Our problem appears to be poor load control of the turbine. With exhaust-steam demand held constant and product-heating requirements constant at the two heaters, turbine throttle flow is erratic. Hunting increases in magnitude if we cut generator load.

We've checked with the turbine manufacturer, but they could find nothing wrong with the throttle controls. Now we would like to hear from any POWER readers who could suggest ways of tackling the problem.—*WSB*

How can we speed steam-line warmup?

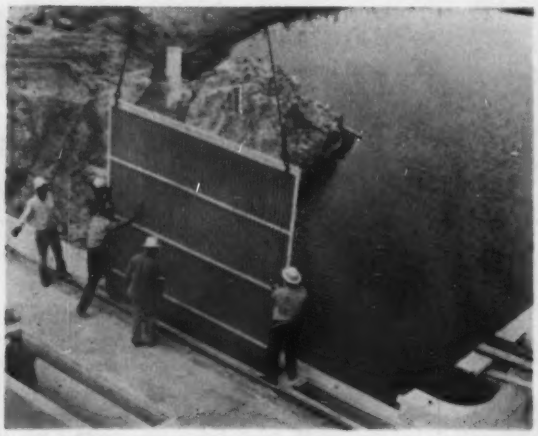
Our process-heating load is supplied by 175-psig steam. Two 50,000-lb-per-hr boilers generate the steam which is carried to three process buildings and several surrounding buildings. Each of these outer buildings contains several steam-heated curing ovens. Ovens are loaded periodically, with up to a week between charges for one oven. Steam temperature is actually controlled by a pressure-reducing valve for each oven.

Our problem is one of man-hours involved in warmup of cold steam lines and heating coils. Each unit must be warmed up slowly and requires the attention of one man about five or six times during the warmup period. This becomes a real headache when several ovens in different buildings are ready for warmup simultaneously. Then we need extra operators.

We would like to know whether any POWER reader has found a way to handle warmup programs automatically, or some faster manual means?—*JFB*

Sit down right now and answer one or both problems. We'll pay extra for answers with photos or sketches

Timely **practical ideas** to help solve



Wrought-iron trash rack fights corrosion

Photo shows a rectangular trash rack lowered into place by workmen at the Indian River Power Plant of the Orlando, Fla. Utilities Commission. This rack, fabricated from wrought iron, is positioned in front of tunnels with the aid of a dragline boom.

Trash racks prevent river debris from getting into water-diversion tunnels and damaging operating equipment. Two racks were set in vertically. They were fabricated from 4x4x3/8-in. angles and 4x3/8-in. bars. Wrought iron was specified because of the metal's corrosion resistance in river waters, along with its resistance to fatigue and abrasion. — *Courtesy, A M Byers Company*

No lube for this bearing

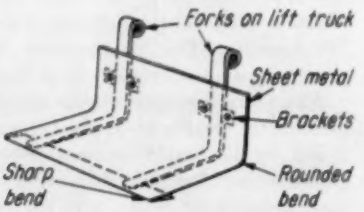
Photo shows a new greaseless bearing developed by the Panelyte Div of St. Regis Paper Company. This bearing material is presently being tested throughout the paper industry. Bearing runs without lubrication of any kind. It's made of a combination of plastic materials which, molded together, give the bearing low static and dynamic friction, resistance to corrosion and high resistance to wear. Results under high load and low speeds have been most encouraging.

These greaseless bearings were first tried on dryer roll journals a year ago. Reports from three separate trials were the same: bearings ran without any lube and without wear.

Several paper companies are presently equipping entire dryer sections with these bearings for a more complete evaluation. It's hoped that entire dryer section will run without lubricants, and power consumption will also be reduced.

Because of the initial success of these bearings, tests are also being run in other phases of the paper-making process—for example in the entire wet end of a paper machine where corrosion normally is a problem.

These new bearings should find application in most industries where machines are used. In tests made by heavy-equipment manufacturers, bearings will be used as flat sliding surfaces. Because of their low static coefficient of friction, prediction is that they'll also find wide use in reciprocating-shaft applications.



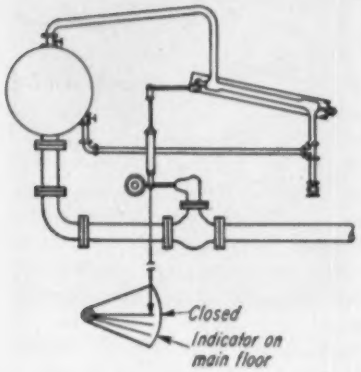
Fork lift removes snow

We made a snow remover out of our fork-lift truck. Snow scoop or pusher is made of heavy-gage metal, sketch, secured to the fork with brackets. Scoop both lifts and pushes snow around our plant. Since we don't have enough snow to warrant buying a snow plow, this scoop saves us tying up a number of men for several days each winter. It's easy to make.

F LETTINO, *Long Island City, N. Y.*

your tricky design and maintenance problems

STEVE ELONKA, Associate Editor

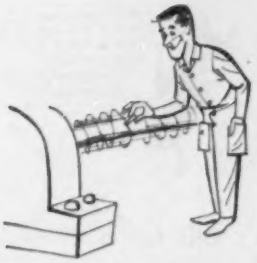


Feed-regulator indicator

In many plants, feedwater regulator valve is set up a long distance above the floor plates. That makes it difficult for the operator to see whether the valve is open or closed.

We solved that problem by drilling a tiny hole in regulator-valve arm, sketch. Then we ran a string down to the operating level and attached a bob. An indicator in back of the bob tells exact valve opening. This idea can also be used with diaphragm, vertical valve-stem regulators located high above the floor plates.

T MULLIN, *Seattle, Wash.*



What would you have done?

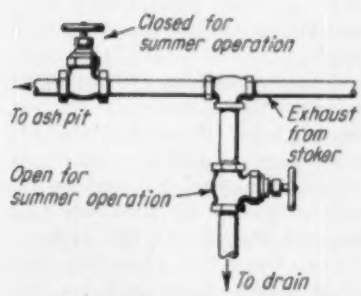
One day I was called to a nearby town to straighten out a vibration problem. An evaporative condenser with a double-wheel centrifugal blower running at 675 rpm was the culprit. Vibration was so bad the state inspectors wouldn't accept the job. Unit was nearly 12-ft long with two 15-in. blower wheels on a 3-in. shaft, supported by end bearings only. I measured the whip at central part of shaft; it came to about ¼ in.

Not having any balancing instruments with me I held a piece of chalk against the shaft while it was running at top speed. Then I shut it down.

I soldered a piece of 2-in.-long wire solder to a fan blade on the side opposite the chalk mark, then started the unit again. By starting the machine again and again and marking the shaft I finally had eight pieces of wire soldered to two fan blades. The unit ran without any noticeable vibration.

Then one of the mechanics used his soldering torch to melt the solder wire over the galvanizing of the blades, making sure balance wouldn't be destroyed by a piece of wire solder thrown from the blower wheels. The inspector accepted the job. What would *you* have done?

Q MINICH, *Hillsdale, N. Y.*



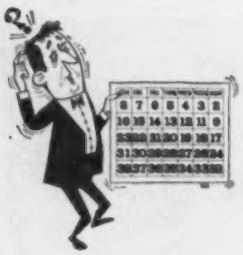
No more wet ashes for us

In our new plant we have several large boiler units equipped with steam-driven single-retort underfeed stokers. During summer months, periods of low steam demand, wet ashes used to plug our ash-blower system and give us a real headache.

Ashes would not run down from the pit. When scraped, they had all the beauty and consistency of wet concrete. The elbow at the vertical 8-in. pipe to the cyclone became badly plugged and we were in trouble.

Checking showed that exhaust steam from the stoker was carried to back of furnace and thence into the ash pit. So we decided to bypass this exhaust steam during the summer months without interfering with its normal operation during periods of high steam demand. Total investment: two 1-in. valves, about 20 ft of 1-in. pipe, a couple of fittings and four hours' labor per unit. Result: dry ashes, at least one-half hour per day saved in shooting ashes, several hours per week saved by not having to clear the ash gun. We avoid countless cuts, bruises, skinned knuckles and general cussedness of the men concerned. Lastly, we save extra steam which used to be lost in extra time required before making this change. We are well pleased.

I H LAWRENCE *(no address given)*



How's this for a calendar?

POWER readers can put this calendar to good use. Why? Because every order is usually marked *rush*, most department heads want work done yesterday. With this calendar you can requisition on the 7th and have the job done on the 3rd. And because most customers want their purchases by Friday, there are two Fridays in each week. This is most important for smooth service.

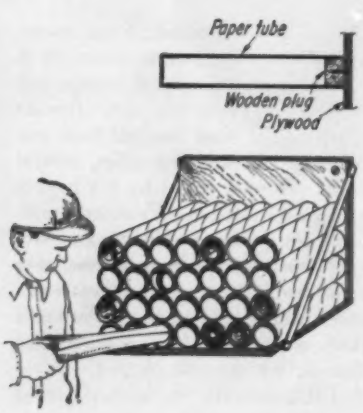
Another nice thing for top management is that there are no unproductive Saturdays, Sundays or holidays in the month. And to solve those end-of-the-month-blues, seven extra days have been added.

But the sweetest thing about this brainstorm is that the 1st, 10th and 25th have been left off, so you never have to pay bills.

Not only that, but each week has a new day—*General*. On this day orders may be cancelled, changes made and other sticky matters reopened. For example, a specification change made on the 8th can reach you on the 5th. This means you can make the change even though the goods were shipped on the 6th.

Courtesy, J A SHERMAN, *Armstrong Mach Wks*

Handy blueprint rack from paper tubes



You can make this handy rack, sketch, from paper mailing tubes, welding-rod tubes or other light tube material usually thrown away. Cut a backing of plywood. Piece of plywood shown for bottom is a refinement, not even necessary. Turn down a wooden plug to fit snugly into the end of each tube. Screw the wooden plugs to the plywood. Then fasten this rack to the wall or place it on a table or bench—you can use it for storing blueprints, plans, specifications, maps—any kind of large easy-to-roll paper around the office.

J K NEAL, *Cuyahoga Falls, Ohio*

My biggest boner

We had been out on a jungle run for months on a 7500-hp diesel ship. I'd had my fill of hard work so I told the chief I was quitting soon as we tied up alongside the dock in San Francisco. My relief came aboard as we lowered the gang plank. He was to relieve me on the four to eight watch that afternoon. I told him the plant might look simple to him, but he ought to hit the floor plates around 2:30 so I could show him around. I didn't want to spend one minute longer on that rust bucket that I had to; she was a hard-luck ship and I was weary of bucking the fates.

He leisurely came below at four pm, right on the dot. I quickly showed him around on my own time, even if he was a smart aleck. That ship had a boiler up in the skylight area, 60 ft up from the floor plates. The boiler was oil-fired in port, ran on waste heat from the diesels at sea. I explained that the remote water glass down below didn't read true. If four in. showed in the remote glass you had only two in. in the boiler. He said he had been around ships long enough and I should get lost.

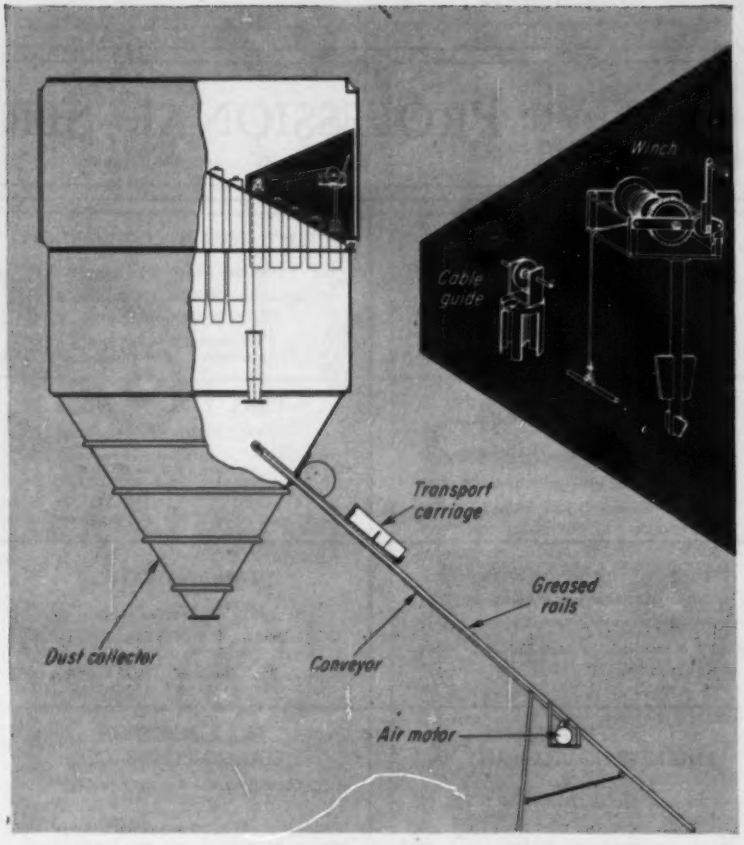
At supper time, when I was packing, he came barging into my room with . . . "Hey Moon, there's water showing on the remotes, the fire is bright, but NO STEAM!" My eyes suddenly crossed and I hit the engine room and flew to the boiler. She was dry as a bone. He hadn't checked the boiler gage as I told him, but stayed on the floor plates and used the remote indicator. All tubes had to be removed—they were a real mess.

Coast Guard held an investigation. Night engineer came on at five pm, day engineer went off at five pm. Both had their licenses suspended, because the Coast Guard couldn't determine who was supposed to be in charge.

Moral to this story: be sure you know your new plant before assuming full responsibility for it.

T MULLINS, *Portland, Ore.*

HAND WINCH speeds raising and lowering



SPECIAL RIG permits faster retubing, solves problem of lugging tubes to and from hopper

Our employee suggestion program paid off when the maintenance - department crew showed how . . .

New rig speeds dust-collector retubing

By E STONE, Maintenance Foreman and A W VAN METER, Plant Engineer, Electric Energy Inc

We have a company-sponsored employees' suggestion program, complete with cash awards for best ideas. Through this medium, a new technique evolved which makes a big dent in dust-collector maintenance costs.

Mechanical dust collectors on our installations were designed with 990 carbon-steel tubes and 990 cast-iron collecting tubes. These need periodic replacement. Confined working areas made removal and installation strictly a manhandling job before our men came up with their brainstorm.

Employees' suggestion: build a small conveyor powered by a 1-hp air motor (see details above). This conveyor transports defective collecting tubes out of the dust-collector hopper, carries new tubes in. Power is needed only for hoisting transport carriage — its own weight brings it back to original position.

Removal and installation of collecting tubes uses a small hand-operated ratchet winch mounted on a turntable attached to a pedestal. Winch pivots to any desired angle. Pedestal acts as vertical support for the winch when inserted into the top of an outlet tube.

Cable guide goes into top of an outlet tube directly above collecting tube to be replaced. It supports as well as guides the cable from winch to tube.

To operate we feed cable from the winch to the cable guide, then down through outlet and collecting tubes. After lifting bar attached to the cable has lodged across the bottom of a defective tube, we take a strain on the cable while removing bolting. When free, tube is lowered to the conveyor for removal. Reverse procedure installs new collecting tubes in short order.

Before maintenance work on the dust collector, entire collector and adjoining gas duct is water-washed to remove all flyash deposits. After washing, we run a light-penetration check to locate defective gaskets, outlet and collecting tubes that need to be replaced.

We feel our mechanical-dust-collector maintenance has grown into an efficient labor-saving operation. Men in our maintenance department who were responsible for the ingenious idea and its perfection deserve full credit. Their technique has proved a real asset to our plant—a moneysaver in time and manpower.

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Position desired—Maint. supervisor or Foreman, age—47, Technical Education, Experience—25 years of power plant maintenance and operation of both high and low pressure systems. Ten years in supervisory capacity. PW-4388, Power.

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1	1800	West.	HF1227	2200	252
1	1000	G.E.	M-575s	2200	1200
1	500	Al. Ch.		2300	293
1	500	West.	CW	2300	594
1	300	West.	CW-955C	2200	1150
1	400	West.	CS-4-32-11	230	1778

SYNCHRONOUS MOTORS—3 Ph., 60 Cy.

2	5000	Al. Ch.		13800/6900	514
1 new	4000	West.		4160/2300	1200
2	1760	G.E.	T8	4160/2300	720
1	1500	West.		2300	514
5	1250	El. Prd.		2200	1200
1 new	920	G.E.		2400/440/230	300
3	700	West.		2300	1200
1	500	West.		2300	1800
1	450	West.		2300	128½
6	1500	G.E.	T8	4160	225

SQUIRREL CAGE MOTORS 3 Ph., 60 Cy.

1	1250	Al. Ch.		2300	3570
3	2000	Ideal	M-5	4160	900
1	800	West.	CS	2300	580
1	800	West.	CS-44	4000/2300/440	1787
1	600	West.	CS	440	3570
1	600	G.E.	K-63298	440	3570
2	450	G.E.	K-63468	2300	3570

TRANSFORMERS — 60 Cycle

Qu.	KVA	Make	Type	Ph.	Voltage
1	3000	G.E.		3	23,500x480
1	1750	Penna.	OISC	3	2200x220
1	1500	West.	Dry	3	4160x2400
6	1500	West.	SL	1	24,000x480
1	800	Wagner		3	2200x220/440
2	833	Penna.	OISC	1	22000x2300
2	750	G.E.	Pyranol	3	4160x480/277

M-G SETS — 3 Ph. 60 Cy.

Qu.	KW	Make	RPM	D.C. Volts	A.C. Volts
2	3500	Al. Ch.	514	250/700	13800/6900/4160
3	1200	G.E.	720	250	2300/4160
1	1000	West.	720	250	2400
1	400	West.	1200	250	2300

INDUCTION HEATING UNITS

1—200 KW, Tocco, 3000 Cycles, 600 Volts.

1—500 KVA, West., 3000 Cycles, 480 Volts Water Cooled.

DUQUESNE ELECTRIC & MFG. CO.

6415 Hamilton Ave., Pittsburgh 6, Penna.

Write for our new catalog.

Circle 507 on Reader Service Card

FOR SALE

675 HP COOPER-BESSEMER DUAL FUEL DIESEL-GAS. 500 KW. 3/60/2300V. COMPLETE.

1275 HP COOPER-BESSEMER DUAL FUEL DIESEL-GAS. 900 KW. 3/60/2300 V. NEW 1953.

3000 KW GE CURTIS CONDENSING TURBO. 400# ISP. 3/60/2300 VOLTS. BUILT 1930. COMPLETE. EXCELLENT.

WHISLER EQUIPMENT CO.

1908 Railway Exchange Building

St. Louis 1, Mo.

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GOVERNMENT PROPERTY

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at

PANTEX ORDNANCE PLANT

Installed ERIE Boilers

(and related equipment)

6 ea 300 HP 1 ea 100 HP

Property may be inspected

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P. O. Box 647 Amarillo, Texas

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2. Largest Water Tube Boilers
3. Steam Generators
4. Industrial Heaters

Design and Sales. Midwest.

P-4613, POWER

520 N. Michigan Ave., Chicago 11, Ill.

ANSWER

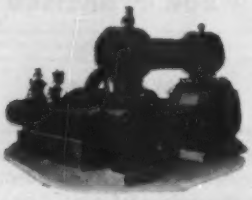
to Worthington Hidden Value Puzzle

The fictitious "hidden value" on the back cover is, of course, the "Full Floating Wrist Pin" in the piston. This construction is found only on light duty compressors with single acting cylinder construction.

Because all Worthington horizontal compressors are heavy duty machines, they are built with the crankshaft, connecting rod and crosshead linkage system illustrated above. It changes rotary shaft motion to linear piston motion without side thrusts on the cylinder walls. Thus wear is reduced and compressor life increased. Worthington Corporation.

COMPRESSORS

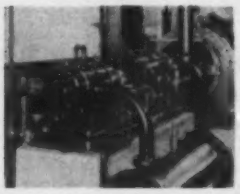
No better values at any price



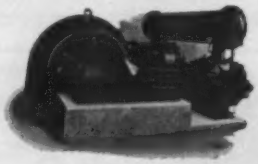
STEAM DRIVEN — NEVER USED

2733 CFM Displacement 80-110# Air Pressure 200 RPM 14½/14½-27½/17 x 28 Unused Ingersoll-Rand XPV-2 "Four Corner" steam driven, two stage, horizontal, duplex, double acting, heavy duty, water-cooled air compressor equipped with simple steam cylinders and complete with: Speed and pressure type throttling governor; Force feed lubricator and oil piping for steam and air cylinders; Intercooler complete with safety valve and pressure gauge; Automatic condensate ejector; Manual reset safety stop protection against overspeeding or low oil pressure; American Type #4-00-H air filter; 54" x 14' vertical air receiver.

2500 CFM 80 PSI 10-10x14 Pennsylvania DE-1 direct connected 300 HP Synchronous 2/60/2300 volts, M-G set and controls. Excellent. New in the Fifties.



1600 CFM Actual Free Air Delivery 100# 600 RPM 300 HP Motor. 3—Fuller Model C300-300H Rotary Multi-Vane, Roller bearing, horizontal, two stage, water-cooled air compressor equipped with: Mechanical force feed lubricator; Oil bath air inlet filter; Separately mounted intercooler; Unloader; Discharge Muffler. FLEXIBLE COUPLED TO: 300 HP Westinghouse 600 RPM, 80% power factor synchronous motor 3/60/440 volt with Westinghouse NA-7A711 across-the-line starter and with 5 KW, 125 volt M.G. set with starter. Now in the Fifties.



— CAN BE SEEN RUNNING —
INSPECTION INVITED

1721 CFM Displacement 80-110# 225 RPM, 23/14 x 16 Ingersoll Rand PRE-2 two stage, double acting, duplex, water cooled, heavy duty, horizontal, synchronous motor driven air compressor with: Step control; Intercooler with safety valve; Mechanical force feed lubricator. DIRECT CONNECTED TO: 285 HP General Electric T8 225 RPM, 80% power factor 3/60/2300 volt engine type synchronous motor complete with exciter and starter.

**For any size or make compressor try American Air.*

AMERICAN
AIR COMPRESSOR CORPORATION
Dell Ave. & Power St. North Bergen, N. J.
UNion 5-4848

Circle 511 on Reader Service Card

CONVERSION & POWER EQUIPMENT

M-G SETS—3 Ph. 60 Cy.

Qu.	KW	Make	RPM	DC Volts	AC Volts
1	4000/4800	G.E. (3U)	450	250/300	2300/4600
1	2300	Whse. (3U)	720	600	2300/4600
1	1750/2100	G.E.	514	250/300	2300/4600
1	2000	G.E.	514	600	2300/4600
1	1500	G.E.	720	600	4000/13200
1	1500	Cr.-Wh.	720	100	2300/4160
1	1250	Whse.	720	600	2300/4160
1	1000	G.E.	900	600	2300/4000
1	1000	G.E.	720	250	2300/4160
1	1000	G.E.	900	300	4000/8000
1	500	G.E.	900	125/250	440
1	500	G.E.	900	250	2300/4000
1	500	G.E. (new)	1200	300	2300
1	400	C-W. (3U)	1200	125/250	2300
1	250	G.E.	900	125	440/4160
2	300	G.E.	1200	250	2300
1	300	Whse.	1200	600	2300/4160
1	200	G.E.	1200	250/275	440
1	300	G.E.	1200	250/275	2300/4160

MERCURY ARC RECTIFIERS

Qu	KW	Make	Type	DC Volts	AC Volts
1	150	G.E.	RF 30	245	208
1	150	G.E.	GRP	275	2300/4160

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltages
1	5000	G.E.	60/50/60	11000/6600
1	2500	G.E.	25/62½	2300/2300

TRANSFORMERS

Qu.	KVA	Make	Type	Ph.	Voltages
2	3333	Whse.	OISC	1	13800x2300
1	3000	A.C.	OISC	3	24300x2300
3	1000	G.E.	OISC	1	13800x480
3	833	A.C.	OISC		13800x2300

TURBO GENERATORS

Qu.	KW	Make	Description
1	1000	G.E.	Non Cond. 125#/5-15# B.P. 2300V.
1	3000	G.E.	Cond. 600#-750° 2400/4160V.
1	4000	G.E.	Cond. 600#-750° 2400/4160V.

A.C. MOTORS — 3 Ph. 60 Cy. Slip Ring

Qu.	HP	Make	Type	Volts	Speed
1	1750	G.E.	M-979DH	4000/6600	1800
1	1500	G.E.	MT-8	4000/6800	1187
1	800	Whse.	CW	550	1776
1	600	G.E.	MT-428	2200	450
1	600	Whse.	CW-22D-18	440	1778
1	600	Whse.	CW	440	850
1	550	Whse.	CW	440	393
		(Unused)			

SQUIRREL CAGE

1	550/275	Whse.	CR-1113	2300	450/900
1	500	G.E.	PT-559Y	2300	3600
3	300	Whse.	CSP-503H	440	3600
4	500	Whse.	CR-1210	2200	600
2	450	Elliott	2010	2200	1185
1	400	Whse.	CR-7181	4000/6800	3600
1	300	Whse.	CR-1002	2300	600
1	300	G.E.	KT-550A	2300	1775

SYNCHRONOUS

1	7000	G.E.	TS-6487	2300/4000	300
1	3300	G.E.	ATI	2300/6900	600
2	1750	G.E.	ATI	2300	3600

RE-HU-BILT BY

BELYEA COMPANY, INC.
43 Howell St., Jersey City 6, N. J.
Tel: OLDFIELD 3-3334

Circle 512 on Reader Service Card

FOR SALE
14 NEW TURBINES

4 horizontal, 10 vertical, Westinghouse
Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 14" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.
Will sell turbines separately if desired.
Price reasonable.
Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volts. Used one year.

G. M. De ROSE
2457 WOODWARD AVE.
706 DONOVAN BLDG.
DETROIT 1, MICH.

Circle 513 on Reader Service Card

NEW EQUIPMENT FROM THE UNCOMPLETED

BATTLESHIP U. S. S. KENTUCKY

Installed but never used
Built of finest materials

WESTINGHOUSE 1250 K.W. TURBO-GENERATORS

(4)—Westinghouse—440/3/60—850°—540 lbs. working pressure. Complete with condensers, circulating pumps, etc.

MAIN CONDENSERS

Mfg. by Foster-Wheeler—23,500 sq. ft. cooling surface—40,500 GPM circulating water—total tubes 8,976, of cupro-nickel, as follows: (550) each ¾" x 0.066 and (8416) each ⅝" x 0.049. Monel water boxes.

BOILERS
7 B&W EXPRESS TYPE

Design pressure 634# — operating pressure 565# — temp. 850°F. Oil fired — separately fired superheaters. *Capacity: 210,000 lb.* steam/hr. ideal for testing where large quantities of steam are required, giving excellent control from separately fired superheaters. Can be converted for #2 oil and natural gas. Fully automatic.

LARGE DEAERATING FEED HEATERS

Monel construction—spray type—capacity 480,000 lbs./hr.—vent condenser—single pass—heating surface 174 sq. ft.—all Monel construction.

GE HIGH AND LOW PRESSURE MAIN PROPELLING TURBINES

Will sell separately for testing, wind tunnel or similar work. (2) high pressure—24,400 HP—12 impuse stages—4909 RPM—working pressure 540 lbs.—825°F. (2) low pressure—28,600 HP — 3913 RPM — working pressure 49 lbs. steam—424°F—2-6 stages of impulse.

THE BOSTON METALS CO.
313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 — LEXINGTON 9-1900

Circle 514 on Reader Service Card

1—Gardner-Denver air compressor, 445 cfm @ 100# pressure, 6 cylinder, 2-stage, 1952. Req. 100 HP.

2—B. Kosler 200 HP water-tube boilers, 100 psi, Stoker fired, 1945.

1—Babcock & Wilcox #32E coal pulverizer, air swept, 75 HP.

1—24" x 338' long trough belt conveyor.

1—Riley Attrita coal pulv., 75 HP.

PERRY EQUIPMENT CORP.
1422 N. 6th St., Philadelphia 22, Pa.
Phone: POplar 3-3505

Circle 515 on Reader Service Card

DIESEL ENGINE GENERATOR UNIT

575 HP, 600 RPM, Worthington Type DH-6 Diesel engine direct connected to 500 KVA—400 KW, 80% PF, 600 RPM, 3 phase 60 cycle, 240/139 volts Electric Machinery synchronous generator complete and equipped with exciter, switchboard with instruments, attached and unattached auxiliaries to the engine. Slightly used—practically new. Immediate delivery.

UTILITIES MACHINERY CORPORATION
1965 East Sixth Street, Cleveland 14, O.

Circle 516 on Reader Service Card

COMPLETE MODERN 400 LB. POWER PLANT

3750 KVA Westinghouse Turbine Generator — 2 600 HP Combustion Engineering Boilers, 450 PSIG W. P. Turbine is 400 PSIG 750° FTT with surface condenser and auxiliaries. Generator 3/60 6900/4160 with Exciter and Switchboard. Surface Condenser and all auxiliaries.

This plant is complete in all respects and can be inspected as originally installed. Photographs, prints and specifications available

Other turbine Generators

1-1500 KW Westinghouse	600# 750° Non-Cond. 150# BP 2400V
1-2000 KW GE	600# 750° Non-Cond. 150# BP 4160V/6600V
2-3000 KW GE	600# 750° Non-Cond. 150# BP 2400/4160V
1-2500 KW Allis Chalmers	400# Autext 150° Non-Cond. 30# 480V
1-2500 KW Westinghouse	125# Non-Cond. 10# BP 2300V
1-2500 KW GE	400# 750° Autext 25# Condensing 600V

Cable Address: CHASWEAVER

CHARLES WEAVER, INC.
19701 JAMES COUZENS HIGHWAY
DETROIT 35, MICHIGAN

Telephone: BRoadway 3-1900

Circle 517 on Reader Service Card

NEW EQUIPMENT

from the unfinished Battle Cruiser "Hawaii"

Material installed but unused, and all in prime condition

8 B&W BOILERS

150,000 lbs/hr—634 lbs. WP—810°TT—6953 sq. ft. generating surface. (Can be converted to natural gas or #2 oil) 11' wide—21' high—15' deep.

4 LARGE DEAERATING FEED HEATERS

833,820 lbs/hr—manufactured by Worthington—test pressure 45 pounds.

4 LARGE ALL-BRONZE 28" MAIN CIRCULATING PUMPS

Manufactured by Worthington—vertical propeller type—axial flow centrifugal pump—driven by geared turbine. 26,500 GPM @ 13.5 T.D.H. lbs/sq. inch. —Suction lift 10'—BHP 300—steam flow per hour 10,000—turbine conditions: 500 lbs & 20 lbs back pressure. Will also operate at 472 pounds with 20 pound back pressure.

8 MAIN CONDENSATE PUMPS

4 motor driven—4 turbine driven—400 GPM @ 56 lbs—11.9" submergence—1170 RPM—BHP 27.3 (Motor driven: GE 30 HP motor 440/3/60—1170 RPM. Turbine driven: Sturdevant turbine—500 lbs —20 lbs. B.P.—27.3 BHP @ 5460 RPM—gear 1170 RPM—1259 lbs. steam/hr.)

THE BOSTON METALS CO.
313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 — LEXINGTON 9-1900

Circle 518 on Reader Service Card

UNUSED—ASSEMBLED—NEW

IN ORIGINAL MANUFACTURER'S PACKING CRATES

BOILERS (Package type)

B&W—80,000 lbs./hr.—475 psig., 740°TTF, oil fired (shipped intact as one integral unit)
B&W—122,500 lbs./hr.—635 psig., 850°TTF, oil fired (unassembled)
B&W—153,600 lbs./hr.—634psig., 850° TTF, oil fired (unassembled)

TURBOGENERATORS

4800 KW GE Turbine—Gen Set, Cond 410psi, 725°TTF, 28.5 Hg exh, 3/93.3/2700V PF 1.0—New
1800 KW GE Turbine—Gen Set, Cond 410psi, 725°TTF, 28.5 Hg exh, 3/60/1735 V PF 0.8—New
1500 KW Westinghouse—Gen Set, Non Cond 400psi, 3/60/480V PF 0.8
1000 KW GE Turbine—Gen Set, Cond 200psi, 600°TTF, 28.5 Hg exh, 3/60/2400V PF 0.8

STEAM TURBINES

1000 SHP GE Cruising Cross Compound, 525psi, 825°TTF, 81psi exh, 10,119/350 RPM with Falk reduction gears—New
3000 SHP GE HP Main propulsion turbine 410psi, 9040RPM, 725°TTF } 1 Set—New
3000 SHP GE—LP Main propulsion turbine 40psi, 9040RPM
11,550 SHP GE HP 12 Stage Cross compound turbine 525 psig, 825°TTF 5870RPM } 1 Set—New
13,450 SHP GE LP 48psig, 4714RPM with Westgh speed decreaser gear assy.
234 HP Worthington-Moore, Non-Cond. Form 22SR, 310psig, 850°TTF, 2psi-exh, 3560RPM

PUMPS, CENTRIFUGAL (Motor driven)

263 GPM @ 375'TDH, Ingersoll Rand—2GT, w/60HP 3525RPM 3/60/220/440V (Used)
275 GPM @ 635'TDH, Ingersoll Rand—2GT, w/75HP 3525RPM 2/60/2300V (Used)
200 GPM @ 1300'TDH, Ingersoll Rand—½CNTA, w/Base, Motor optional

PUMPS, CENTRIFUGAL (Turbine driven)

460 GPM @ 750psi discharge, Worthington, w/350HP turbine, 575psi, 4900RPM—New

BLOWERS, TURBO-CENTRIFUGAL

20,000 CFM @ 17"WC, Westinghouse, Vaneaxial, w/Turbine, 82.5HP, 375psi, 10psi—exh, 4825RPM—New
24,000 CFM @ 28"WC, Sturtevant Co, Rexvane, w/Turbine, 191HP, 400 psi, 10psi—exh, 3525RPM—New
43,000/50,000 CFM @ 9"/11"WC, Sturtevant, Turbovane, w/Turbine 86/141HP, 400psi, 10psi —exh, 4980/5870RPM—New

WABASH POWER EQUIPMENT CO.
9750 SKOKIE BLVD., CHICAGO (Skokie), ILLINOIS
TEL. OR. 3-8118

Circle 519 on Reader Service Card

37 Years Dependable Service

SLIP RING MOTORS 3 Ph., 60 Cy.

H.P.	Volts	Make	Speed
500	4000/2300	G.E.	600
450	4000/2300	G.E.	1200
400	2300/440	G.E.	600
400	4000/2300	Whse.	720
350	4000/2300	G.E.	720
300	2300	G.E.	900
300	440	G.E. (hoist)	600
300	440	Whse.	3600
225	4000/2300	G.E. (hoist)	600
200	2300	G.E.	600
200	2200/440	G.E.	720
125	2300	G.E.	600

AC GENERATORS or SYN MOTORS, 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2300	G.E.	TS	1800
400	2200/440	G.E.	ATI	720
300	2200/440	G.E.	TS	1200
200	440	G.E.	TS	900
150	440/220	Whse.	O	1200
125	440/220	Whse.	HR	600

SQUIRREL CAGE MOTORS

500	2200/4000	Elliott	SC	1800
400	2300	G.E.	FT	3600
400	2300/4000	G.E.	K	1200
350	2300/4000	G.E.	SEDP	3600
350	2300/4000	G.E.	K	900
300 (2)	2300	G.E.	FT	3600
300	2300/4000	L. Allis.	FS	1800
300	2300/4000	Cont'l.	Spl.-Prf.	720
300	2300/400	G.E.	KT	900
250	2300/4000	G.E.	K	720
200	2200	G.E.	KT	1800
200	2200	Cont.	TEFC	3600
150	440	Whse.	X-pf.	3600
150	440/220	Cont'l.	X-pf.	1800
150	440/220	G.E.	TEFC	720
150	2300/440	G.E.	TEFC	3600
125	2300/440	G.E.	FT	1200
100	440	Whse.	X-pf.	3600
100 (2)	440	Cont.	X-pf.	1800
100 (2)	4000/2300	L. Allis	OX	1200
100	2300	Cont'l.	OX	1200
60 (2)	440	Cont'l.	X-pf.	1800

CIRCUIT BREAKERS, 3 Pole

4—1600 Amp., DA-50, Whse., 600 V., Air
1—600 Amp., G.E., 15 KV, Sol. oper.
3—600 Amp., G.E., 15 KV, manual
1—600 Amp., Whse., 7.5 KV, outdoor, New.

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
150	230	El. Dyn.	B/brg.	600
80	230	G.E.	CD	1750
50	230	G.E.(4)	CD	1150

MOTOR GENERATOR SETS

KW	Make	Input., AC	Motor Type	Output V., DC
300	Whse.	4150/400	Syn.	250/125
150	G.E.	440/220	Syn.	250
125	G.E.	440/220	Sq. Ca.	125
100	G.E.	2300/440	Syn.	250
75	Cr. Wh.	440/220	Sq. Ca.	250/120
65	G. E. B	2300/440	Sq. Ca.	250

TRANSFORMERS 60 Cy.

1—500 kva, Al Ch. 2400/4160Y—400 volts, 3 ph.
2—500 kva, G.E., 13800—240/480 V.
2—200 kva, Mol., 13,800—2300 V.
3—333 kva, G.E., 13,800—2400 V.
3—333 kva, G.E., 2400—240/120 V.
3—333 kva, Mol., 2400—240/480V.
2—200 kva, G.E., 2400—460V. Pyr.
3—200 kva, G.E., 13,800—400 V.
3—200 kva, G.E. 4150—480/240 V.
3—167 kva, Whse., 4150—480 V.
3—150 kva, Al. Ch., 2400—220 V.
3—150 kva, G.E., 13,200—2300 V.
2—100 kva, Whse., 2400—240/480 V., Dry
3—100 kva, G.E. 2400—120/240 V., Pyr.

GASOLINE—ENGINE GENERATOR SETS

3—37½ kva, 1800 R. 230 V 3/60, Cont'l., 6 cyl.

only partial listing

STEPHEN HALL & CO.
HARRY J. RICE, Pres.
625 ADAMS ST., HOBOKEN 2, N. J.

Circle 520 on Reader Service Card

HERCULES DIESEL ENGINE GENERATOR SETS

NEW — 1959 — Portable — Skid Mounted — 8 Cylinder 1800 RPM 0.8 P.F.

30 — K.W. — 120/208-Volts — 3 phase — 60 cycle, 4-Wire with Neutral for single phase. Enclosed—Designed for outdoor use. Heated for fast winter starting. Complete with Switchboard & Engine Panel. Automatic Voltage Regulation. Inspection under power invited. Immediate Shipment from Phila. or Miami, Fla.

Sale or Rent

T. B. MacCABE CO.
4314 Clarissa St. — Philadelphia 40, Pa.
Phone — DAvenport 4-8300

Circle 521 on Reader Service Card

SPECIAL OFFERING!

3 NEW UNUSED 850 KW DIESEL GENERATOR SETS

installed but never run

ENGINE:

Fairbanks-Morse model 38D8 ⅛—bore & stroke 8½ x 10—@ 720 RPM.

GENERATOR:

Complete—drip-proof enclosure—850 KW 440/3/60 @ 720 RPM—80% P.F.—with direct-connected 7½ KW exciter.

The above units are complete with filters, strainers, heat exchangers, mufflers, air intake silencers, etc., and are complete in every detail. They are mounted on a common pre-fab sub-base, and have the latest deadfront switchgear, distribution & voltage regulators. These units are perfect in every respect & have been carefully preserved by the U.S.N. Can be seen in our warehouse or aboard the "Hawaii."

THE BOSTON METALS CO.
313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 — LEXINGTON 9-1900

Circle 522 on Reader Service Card

MUST BE SOLD IMMEDIATELY

No reasonable offer refused

- Richardson coal scale 200 lb dump. 20t. hr. cap. Excellent condition.
- 200 ft. bucket conveyor complete, bucket size 9" x 16" x 20"
- United ash vacuum unloader, with ash intake, 8" conveyor pipe, ash receiver, exhauster, air washer & 2,200 cu. ft. steel hopper with worm dustless unloader.
- Cochrane hot process softener, 125 lbs. per hr.
- Steam Generator. 110,000 lbs steam per hr. peaks to 140,000. 675 lbs. sq. in., air preheaters, forced and induced draft fans & controls. Will sell complete or piecemeal.
- Steam Generators. 2500 & 3000 KVA. All new blades, diaphragm, nozzles in the last 5 yrs.

COREY BLDG., WRECKING
LOWELL, MASSACHUSETTS
GLENVIEW 2-8908

Circle 523 on Reader Service Card

SEARCHLIGHT EQUIPMENT LOCATING SERVICE

No Cost or Obligation

This service is aimed at helping you, the reader of "SEARCHLIGHT", to locate Surplus new and used power equipment not currently advertised. This service is for USER-BUYERS only. How to use: Check the dealer ads to see if what you want is currently advertised. If not, send us the specifications of the equipment and/or components wanted on the coupon below, or on your own company letterhead to:

SEARCHLIGHT EQUIPMENT LOCATING SERVICE
c/o POWER
Classified Advertising
P.O. Box 12, N. Y. 36, N. Y.

Your requirements will be brought promptly to the attention of the equipment dealers advertising in this section. You will receive replies directly from them.

SEARCHLIGHT EQUIPMENT LOCATING SERVICE,
c/o Power,
P.O. Box 12, N.Y. 36, N.Y.

Please help us to locate the following used equipment:

.....

.....

NAME .....

TITLE ..... COMPANY .....

STREET .....

CITY ..... ZONE ..... STATE .....

7/60

TRANSFORMERS—60 CYCLE

Qu	KVA	Make	Type	Phase	Voltages
2	3000	Maloney	TCR	3	7200/6930-4160/3400
2	750	G.E.	K	1	4600-120/240
1	300	Pauna.	(Askarel)	3	12470Y/7200-240
3	250	G.E.	H Pyranol	1	4800/2820Y/120/240
3	200	G.E.	HSP2F	1	2400/4160-240/480
2	200	Amer.	CC	1	4160/7200-240/480
3	75	G.E.	KF	1	2400/4160-120/240
3	50	G.E.	H	1	2400/4160-240/120
1	50	Amer.	Abestol	3	4160-120/208Y
4	25	West.	Hypersil	1	2400/4160-120/240
6	25	G.E.	Dry	1	2300-440

MOTOR GENERATOR SETS

Qu	KW	Make	Speed	DC	AC
1	75	EM	1200	250	Syn. 230V.
1	75	G.E.	1200	125	2300/4160 Syn.
1	175	West.	1200	125	4150 Syn.
1	300	G.E.	1200	250	2300/4160Y SR
1	300	Al.-Ch	1200	125/250	Syn. 440V.
1	1000	West.	720	600	2300/4160Y
1	45	Cent.	1200	30	75 HP-440V Sq Cg

ENGINE GENERATOR SETS

1—Hercules Gas HXE 62.5 KVA Westghe 3/60/480 —1200

SLIP RING MOTORS

Qu	HP	Make	Speed	Type	Volts
3	40	West.	800	CW	220/440
1	60	G.E.	1800	MT	220
1	60	G.E.	850	MT546	440
1	75	G.E.	600	IM	440
1	100	West.	1200	T.E.F.C. B.B.	220
2	150	Allis-Ch.	1800	AT-RW	2300
1	250	West.	600	CW	440
1	350	West.	1000	CW	2300
1	450	West.	1800	CW-4-30-0	220
1	500	G.E.	450	MT	2200
1	500	G.E.	1200	M360Z	2200/4160Y
1	50	G.E.	870	MT352	220/440

D. C. MOTORS—230 VOLTS

Qu	HP	Make	Speed	Type
1	350	G.E.	1200	Pedestal
1	30	G.E.	1750	172 FR
1	30	West.	890/1400	SK-4G1542

SQUIRREL CAGE MOTORS, 3 PHASE, 60 CYC.

1—300 HP, 1200, Allis. Chalmers, 2300/4160Y
1—275 HP, 1180 RPM G.E. Type KT 6503B5 2300V
2—200 HP, 1790 RPM, G.E. Elec. KF, TEFC, 2300V
2—150 HP, 1800 G.E. TEFC Exp. 220/440
1—100 HP, 1775 RPM G.E. KTF-548 3 ph 40-440V.
1— 75 HP, 3600 RPM Cont. NP 505—440V Exp. P
1— 50 HP, 3600 Cont. Ex. Pr. 220/440
2—100 HP, 3600 RPM Cont. NP 585-8 440V Exp. Proof
1—150 HP, 3600 RPM, G.E. 956Y 2300V. Type T8

MOTORS—SYNCHRONOUS—3 ph. 60 cy.

100 HP 900 RPM G.E. Pum BL 2300V.
125 HP 600 RPM G.E. Type T8 2300 V.
125 HP 900 RPM Elect. Mach. 4600 V.
150 HP 3600 RPM G.E. Type T8 Pr. 956Y 2300 V.
150 HP 1800 RPM G.E. Type T8 230 V.
200 HP 720 RPM Elec. Machinery L.e.f.c. 2300 V.
325 HP 900 RPM West—2300 V.
400 HP 450 RPM Westinghouse Type HR 440 V.
75 HP 1200 RPM Crocker-Wheeler Type ALT 230/440V B.B.

FOR POWER
J. L. HEMPHILL & CO.
1603 54th STREET, NORTH BERGEN, N. J.
PHONE NEW YORK—LONGACRE 5-2237

Circle 524 on Reader Service Card

AUTOMATIC and MANUAL
Gas or DIESEL GENERATOR UNITS
Complete Switchboard Design and Construction
USED & REBUILT EQUIPMENT
UNIVERSAL POWER ENGINEERING CO.
382 Wayne St. Jersey City, N. J.
Phone: DElaware 2-8300

Circle 525 on Reader Service Card

Your inquiry will have Special value...

If you mention this magazine, when writing advertisers. Naturally, the publishers will appreciate it . . . but, more important, it will identify you as one of the men the advertiser wants to reach with this message . . . and help to make possible enlarged future service to you as a reader.

CHECK WITH WAGNER FIRST!

Thousands of new and "Certified Rebuilt" Motors & Generators in stock—up to 1000 H.P.
OUR 54th YEAR

A. C. MOTORS—60 CYCLE

HP	Mfr.	Type	Volts	Speed
800	Whse. (2)	Sq. Cage	2300	1800
750	G.E.	Slipring	2300	514
600	G.E.	Synch.	488	900
600	Elliott (2)	Sq. Cage	2300	900
500	Al. Ch. 3 brg.	Slipring	440	514
500	Allis Ch.	Slipring	2300/440	600
400	G.E.	Sq. Cage	440	1200
400	Whse.	Sq. Cage	2200	514
400	Marathon (2)	Sq. Cage	2300	3600
400	G.E.	Slipring	2300	514
400	El. Machy.	Synch.	2300/1000	400
350	El. Machy.	Synch.	2300	900
350	Br. Boveri b.b.	Sq. Cage	4600/440	720
350	G.E.	Sq. Cage	2200	1800
350	Allis Ch.	Slipring	2200/4000	600
300	G.E.	Slipring	220/440	514
275	G.E.	Sq. Cage	2200/440	1200
250	G.E.	Sq. Cage	2200/440	450
250	Gen. Elec.	Sq. Cage	440	3600
250	G.E. TEFC	Sq. Cage	440	1200
250	Whse.	Sq. Cage	2300/440	600
250	Whse. (4)	Slipring	2300/440	600
200	Gen. Elec.	Synch.	350/440	400
200	G.E. b.b.	Sq. Cage	220/440	720
200	G.E.	Slipring	220/440	450
200	G.E.	Slipring	440	600
200	G.E.	Slipring	2200	900
200	Reliance b.b.	Sq. Cage	220/440	1800
200	Allis Ch.	Slipring	2200/440	720
150	Whse. XP	Sq. Cage	440	3600
150	G.E. (4)	Slipring	2200/440	600
150	G.E. (2)	Sq. Cage	2200/440	1800
150	Whse.	Slipring	220/440	1200
150	Whse.	Slipring	2300	450
125	A.C. TEFC	Sq. Cage	220/440	1800
125	El. Machy. (2)	Synch.	220/440	400
125	G.E. TEFC	Sq. Cage	2200	3600
125	Al. Ch. TEFC	Sq. Cage	220/440	600
125	G.E. (2)	Slipring	220/440	514
125	Mar. TEFC	Sq. Cage	220/440	1200
100	Allis Ch.	Slipring	2300/440	600
100	Al. Ch. TEFC	Sq. Cage	2200	1800
75	G.E. b.b. (8)	Sq. Cage	220/440	1200

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
300	Gen. Elec.	CY-221	250/350	1200
200	Gen. Elec.	RC	250	1450
100	Delco b.b.	late	120/240	1200
75	Allis Ch. b.b.	EB-146L	125	1500
75	G.E. b.b.	CD	250	1750
60	Ideal	D	125	1150
60	G.E. b.b.	CD	600	1750
50	G.E. (2)	CD-1129	250	1200

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
250	Cr. Wh.	161-H	230	1150
200	G.E. (2)	RC-38	230	1150
200	Whse. b.b.	SK	250	287/575
150	Rel. TEFC b.b.	2556-F	230	850
150	Whse.	SK-210	230	320/1000
125	G.E.	CD-173	230	575/1150
100	Elliott b.b. T.E.	JH-FE	230	1150
100	El. Dyn. b.b. (2	36-S	230	450/1200
75/100	Whse.	SK-191	230	500/900
75	G.E. b.b.	CD-115	230	1150
60	G.E. TEFC b.b.	CD-135	230	1150
50	G.E.	RF-16	230	250/1000
50	Century new	DN-514	230	1150/1750
40/50	Reliance b.b.	310-T	230	600/1800

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
600	Allis Ch.	440 AC	250 DC
300	Whse. (2)	2200/440 AC	250 DC
200	Allis Ch. (2)	440 AC	55 DC
200	Whse. synch.	220/440 AC	250 DC
200	Gen. Elec.*	220/440 AC	125 DC
125	Gen. Elec.*	2300/4000 AC	250 DC
125	Whse.	220/440 AC	250 DC
100	Delco b.b.	220/440 AC	120/240 DC
80	Star b.b. Synch.	220/440 AC	250 DC
75	Whse. Synch.	220/440 AC	250 DC
60	Ideal	220/440 AC	125 DC
50	Whse. synch.	220/440 AC	250 DC

Arthur Wagner Co. Certified
MO nroe 6-7409
1435 W. RANDOLPH ST
CHICAGO 7, ILLINOIS

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TRANSFORMERS

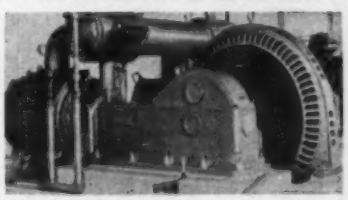
BOUGHT · SOLD · RENTED
REWOUND · RE-DESIGNED
MANUFACTURED
Ask for our Stock List

For Sale
3—2500 KVA G-E 69000—2300Y
3—2500 KVA G-E 69000—2400/4160Y
3—2500 KVA G-E 69000—7200/12470Y
4—2500 KVA W-H 34500—2400/4800
3—1500 KVA G-E 69000—2300Y
3—1500 KVA G-E 69000—2400/4160Y
3—1500 KVA G-E 69000—7200/12470Y

THE ELECTRIC SERVICE CO., 5322 Hetzel St., Cincinnati 27, Ohio
"America's Exclusive Independent Transformer Service Shop"

Circle 527 on Reader Service Card

LARGE CAPACITY
AIR COMPRESSOR



700 HP—WORTHINGTON—3468 CFM
125 PSI — LATE STYLE
Inspect on Original Foundation
EARL E. KNOX CO.
1109 BACON ST. ERIE PA.
GL 6-7037

Circle 528 on Reader Service Card

NEW G.E. A.C. MOTORS
FOR HYDRAULIC PUMPS OR HYDRAULICALLY DRIVEN DECK MACHINERY OR CRANES

New, as removed from U.S. Naval vessel Hawaii.

ALL A.C. 440/3/60

10 HP Continuous — 40 HP intermittent ½ hour. High slip, high torque, induction, type KH. 2 available.
10 HP Continuous—40 HP intermittent ½ hour.—1040/520 RPM. 1 available.
(The above two motors have magnetic brakes.)
15 HP Continuous—60 HP intermittent ½ hour. 1770 RPM—type KF.
20 HP Continuous—1770 RPM—type KF.
40 HP Continuous — wound rotor — 440/3/60 — 585 RPM Type M. 1 available.
18¾ HP Continuous—75 HP intermittent ½ hour —1775 RPM—2 available—type KF.

THE BOSTON METALS CO.
313 E. Baltimore St., Baltimore 2, Md.
ELGIN 5-5050 — LEXINGTON 9-1900

Circle 529 on Reader Service Card

POWER EQUIPMENT DIVISION

GENERATOR SETS

11—1250 KVA Natural Gas Engine Sets
3/60/2400/4160 with switch gear
(can be seen running)
1—500 KW Condensing 200 PSI Turbine

TRANSFORMERS

1—6000 KVA 3/60/44000—4160 Substa.
3—500 KVA 1/60/66000— 480
6—450 KVA 3/60/13800— 460
3—333 KVA 1/60/2300/4160 Y—480

CRANES

40/10 ton OET 47'3" Span 75' Lift AC
25 ton Powerhouse 36'6" Span AC
6 ton OET 43' Span 20' Lift DC

BOILERS

40,000#/hr. 225 PSI B&W Type F22
25,000#/hr. 450 PSI @ 738°F. Stirling
18,000#/hr. 160 PSI Keeler

NEW UNASSEMBLED B&W, F.W., C.E. complete with Superheater, Economizer, Soot Blowers, Oil Burners, Steel Encased
44500#/hr. 450 PSI 735°F.
35000#/hr. 285 PSI 577°F.

HEAT & POWER CO. INC.

60 East 42nd St., New York 17, N.Y.
310 Thompson Bldg., Tulsa 3, Okla.

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POWER EQUIPMENT

6000 KW, G.E. Cond. Turbo-Generator 3/60, 2400 V. 3600 RPM, 200 PSI
5500 KW, G.E. N.C., Turbo-Generator 3/50, 2300 V. 3000 RPM, 600 PSIG 650°TT, 150# B.P.
1500 KW, G.E. Cond. Extr. Turbo-Gen. 3/60, 2400 V. 3600 RPM 200/400 PSIG, 750°TT, 15# Extr.
1000 KW, Worth.-Moore, Cond. Extr. Turbine, 3/60, 245/490 V, 3600 RPM, 130-300#, I.P., 10# Ext.
300 KW, G.M. 8-268A, Diesel Units (2) 3 ph. 60 cycle, 480 V. 1200 RPM.
500 KW, 80% P.F., West. 3/60, 240/480 V, 300 RPM, Gen. direct conn. to Ames Vertical Uniflow Engine.

BREW, WOLTMAN & COMPANY, INC.

50 CHURCH ST., N.Y. 7, N.Y.

Circle 531 on Reader Service Card

MODERN G.E. RECTIFIERS

4—1000KW Mod. 6RC-45-CD6 Auto. Subs.
2— 500KW Mod. 6RG-45-CH2 Auto. Subs.

1948 Vintage still like NEW condition. Can be inspected under power at Birmingham. Priced at $25. per KW (Less than ¼ replacement).

S. M. DAVIS Box 1407, E. St. Louis, Illinois

Circle 532 on Reader Service Card

MOTORS • GENERATORS
TRANSFORMERS
NEW • REBUILT

ELECTRIC EQUIPMENT CO.

WORLD'S LARGEST INVENTORY
CALL COLLECT GL 3-6783
P.O. BOX 51 • ROCHESTER 1, N.Y.

Circle 533 on Reader Service Card

FROM AIRCRAFT CARRIER "ENTERPRISE"

[4] 1000 KW GEARED TURBO-GENERATORS

For Condensing or Non-Condensing

1000 KW TURBO-GENERATOR COMPLETE WITH CONDENSERS CIRCULATING PUMPS CONDENSATE PUMPS AND SWITCH GEAR

GENERATOR: 1000 KW — type ATB-2 — G.E. — form H.L.—1250 KVA—3/60/450—1605 amps—3600 RPM—0.8 P.F.—Gold amps 67—typical serial No. 5338205—with 120 volt 11KW DC exciter—compound wound.

STEAM TURBINE: 1000 KW G.E.—type FSN-4R-FN30-85TG—rated 7984 RPM—exhaust 1 lb. absolute when condensing.

REDUCTION GEAR: S-11B—form A—RPM 7984/3000.

TURBINE STEAM PRESSURE: 575 lbs—175°F superheat—exhaust pressure 1 lb. absolute when condensing. Can be used condensing or non-condensing. Can be operated at reduced pressures.

BUILT AS MARINE UNITS USING FINEST MATERIALS. DRIP - PROOF CONSTRUCTION. UNITS ARE 16' LONG — 7'8½" WIDE. MOUNTED ON PRE-FAB SUB-BASE.

THE BOSTON METALS CO.

313 E. Baltimore St. Baltimore 2, Md.
ELGIN 5-5050 LEXINGTON 9-1900

Circle 534 on Reader Service Card

DUAL FUEL DIESEL ENGINE GENERATOR UNITS

1050 KVA Nordberg supercharged dual fuel diesel engine generator unit 3 phase 60 cycle 2400 volts 327 RPM. New 1947—Excellent condition.

1250 KVA Worthington supercharged dual fuel diesel engine generator unit 3 phase 60 cycle 2400/600/480 volts 360 RPM. New 1949—Excellent condition.

1420 KVA Fairbanks Morse opposed piston diesel engine generator unit 3 phase 60 cycle 2400 volts 720 RPM. New 1950—Excellent condition.

The above units are still installed and complete with all auxiliaries as in operation.

INTERNATIONAL POWER MACHINERY CO.

1612 Union Commerce Bldg. — MAin 1-9514
Cleveland 14, Ohio

Circle 535 on Reader Service Card

TRANSFORMERS

1—16667 kva G.E. 3/60/88000/11500
1— 6667 kva Westinghouse 3/60/115,000Y/13750
1— 6000 kva G.E. 3/60000/2400/4160Y
1— 2000 kva Nia. Askarel. 3/13800/4160Y/2400 new
1—5000/6250 kva. GE 1/60/115,000 pri. 11,500 sec. unused
1— 800 kva Penna. 3/60/2400/4800 pri. 120/208Y Sec.
3— 1500 kva Wagner, 1/60 cy. 6900—2400/4160Y
2— 1000 kva Standard, 1/44000/2000
3— 1000 kva Standard, 1/60000/4160Y/2400
3— 1000 kva Standard, 1/34400/480
3— 833 Allis Chalmers 1/60/12,000-480
3— 750 kva. GE 1/60/13,800 pri. 480 sec.
3— 500 kva. GE 1/60/11,500 pri. 480 sec.
3— 333 kva. GE Spirakore 1/60/2400/4160Y, 480
3— 333 Kva. GE Spirakore 1/60/2400/4160Y pri. 120/208Y sec.
3— 333 kva G.E. 13200/480
3— 150 kva. Uptegraff 1/60/4800 pri. 480 sec.
3— 250 kva. dry Standard. 1/60/2400/4160Y pri. 240/480 sec.
3— 150 kva G.E. 1/60/2400/4160Y pri. 240/480 Sec.
3— 100 kva. Uptegraff 1/60/2400/4160Y pri. 240/480 sec.
3— 100 kva. GE H.K. 1/60/4800/8320Y pri. 480 sec.
3— 100 kva G.E., 2400/4160Y—120x240
3— 75 kva G.E., 2400/4160Y—120x240
3— 50 kva WEST CRP. 4160/7200Y, 120/240

ERIE ELECTRIC CO., INC.

28 Mechanic St. Buffalo 2, N. Y.

Circle 536 on Reader Service Card

JULY POWER SPECIALS

We own and Offer

1—400 KVA SUPERIOR DIESEL SET 3/60/2300 or 480v 450 rpm. All Accessories—On Foundations, Harrisburg, Pa. New 1950—For Quick Sale—where is—$8500.00.

2—515 CFM Ing. Rand Air Compressors Size 90, Model 40, 125 psi, Base Mounted with 100HP 3/60/220/440 Motors—Late—Guaranteed. Ready Ship—Phila. Stock. One Unit—$4750.00. 2nd Unit—$4250.00.

1—40,000 Lb/Hr. Water Tube Package Boiler, 250 psi, ASME Oil or Gas—New January, 1960 Never Used—Immediate Shipment. Save Thousands of $s.

1—375KVA De Laval Steam Turbine Generator Set Non-condensing 3/60/480-2300v/3600rpm — 175 psi—0/20Lb. Exhaust. Excellent. Inspect at our Philadelphia Shops.

THE O'BRIEN MACHINERY CO.

1915 W. CLEARFIELD STREET
PHILADELPHIA 32, PA.

Circle 537 on Reader Service Card

For sale at very attractive price on where is as is basis, the following Gas Engine Driven Electric Generator sets, all in running condition.

1— 180 KW Belt Driven
2— 200 KW Belt Driven
3— 210 KVA Direct connected
4— 435 KVA Direct connected
5— 312 KVA Direct connected
6— 312 KVA Direct connected
7— 435 KVA Direct connected
8— 195 KVA Direct connected
9— 195 KVA Direct connected
10— 813 KVA Direct connected
11—1563 KVA Direct connected
12— 250 KVA Hydro Direct connected

All Units are 2300 Volt, 3 Phase, 60 Cycle, 0.8 P. F.

Farmington Electric Utility System
P. O. Box 667
Farmington, New Mexico

Circle 538 on Reader Service Card

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CLEVELAND, 13
1164 Illuminating Bldg. *SUperior 1-7000*
W. B. SULLIVAN

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1712 Commerce St., Vaughan Bldg. *RIverside 7-5117*
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SAN FRANCISCO, 4
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S. HUBBARD

AXIAL FLOW FANS

From unfinished Battle Cruiser "Hawaii"

All New! Installed but never run!

RELIANCE MOTORS—ALL 440/3/60

22500 CFM @ 3.4" static pressure; 25 HP @ 1780 RPM—30" ID top; 54" OD bottom; 40" long.

16810 CFM @ 3" static pressure; 15 HP @ 1760 RPM—30" ID both ends; 36" long.

17750 CFM @ 3" static pressure; 15 HP @ 1760 RPM—33½" ID both ends; 36" long.

17475 CFM @ 3¼" static pressure; 15 HP @ 1760 RPM—36" ID both ends; 36" long.

17040 CFM @ 4" static pressure; 17½ HP @ 1735 RPM—30" ID top; 51" OD bottom; 37" long.

16065 CFM @ 4.2" static pressure; 15 HP @ 1760 RPM—36" ID top; 51" OD bottom; 37" long.

16600 CFM @ 3.7" static pressure; 15 HP @ 1750 RPM—36" ID top & bottom; 37" long.

15840 CFM @ 3.4" static pressure; 15 HP @ 1760 RPM—30" ID top; 51" OD bottom; 37" long.

15820 CFM @ 4" static pressure; 15 HP @ 1760 RPM—30" ID top; 51" OD bottom; 37" long.

13815 CFM @ 3¾" static pressure; 12½ HP @ 1780 RPM—34" ID both ends; 37" long.

11550 CFM @ 3.2" static pressure; 10 HP @ 1740 RPM—31½" ID both ends; 37" length.

10000 CFM @ 2.65" static pressure; 7½" HP @ 1745 RPM—29" ID top; 33" OD bottom; 39½" long.

8820 CFM @ 3.2" static pressure; 7½ HP @ 1730 RPM—27" ID top; 36" OD bottom; 39½" long.

5990 CFM @ 3" static pressure; 5 HP @ 1760 RPM—23" ID both ends; 31" length.

5180 CFM @ 2.1" static pressure; 3 HP @ 3450 RPM—23" ID both ends; 30" long.

4890 CFM @ 3" static pressure; 3 HP @ 3450 RPM—23" ID both ends; 30" long.

3780 CFM @ 2.5" static pressure; 3 HP @ 3450 RPM—23" ID both ends; 30" long.

3080 CFM @ 3.4" static pressure; 3 HP @ 3450 RPM—23" ID both ends; 30" long.

2200 CFM @ 3" static pressure; 1½" HP @ 3500 RPM—15½" ID both ends; 23" long.

THE BOSTON METALS CO.

313 E. Baltimore St., Baltimore 2, Md.

ELGIN 5-5050 — LEXINGTON 9-1900

Circle 539 on Reader Service Card

BOILERS NEW UNASSEMBLED

# Steam/hr.	Key	PSI	Temp.
122,500	DF	565	850
121,650	DF	565	850
60,000	SF	435	750
74,000	H	280	500
55,000	A	240	—

DF Double Furnace, SF Single Furnace (illustrated), bent water tube boilers w/economizers and superheaters, B & W's and Foster Wheelers.

H Header type, straight tube, B & W.

A 3 drum, single furnace, Wickes.

Pelnik-Loconti Industrial Supply, Inc.

315 Oriskany St., Yorkville, N.Y.

Utica, N. Y. Ph. RE 6-4621, RE 2-4513

Circle 540 on Reader Service Card

MISS POWER EQUIPMENT SAYS,
"For BIGGER SAVINGS and BETTER SERVICE, Get Our BARGAIN PRICES on Guaranteed NEW and REBUILT MOTORS"

SQUIRREL CAGE MOTORS NEW AND GUARANTEED REBUILT

HP	Make	Type	Speed
500	L.A. B.B. Splash. 440 Volt	FX-1465	3600
500	G.E. S.B. Open	IK	1200
450	West. S.B. Drip	CSP-681	1800
400	L.A. B.B. Splash	L	1800
400	G.E. S.B. Open	IK	1200
400	G.E. S.B. Open	IK-178	900
400	West. S.B. Open	CS	900
350	West S.B. Drip	CS-22356H	1200
300	G.E. S.B. Open	IK	1800
300	G.E. S.B. Open	IK	900
300	Cont. B.B. Splash	N-804	900
300	G.E. S.B. Open	IK	720
300	G.E. S.B. Open	KT-561	720
300	West. S.B. Open	CS-1002	600
300	G.E. S.B. Open	IK	600
250	G.E. S.B. Open	KT	1800
250	West. S.B. Splash	CS-873	1800
250	G.E. S.B. Open 2200 Volt	IK-10	1200
250	G.E. S.B. Open	IK	1200
250	G.E. S.B. Open	IK	900
250	G.E. S.B. Open	IK	720
200	G.E. S.B. Drip	K-5823	1800
200	West. S.S.B. Open	CS-956	1800
200	West. S.B. Open	CS	1200
200	G.E. S.B. Open	IK-15	1200
200	G.E. S.B. Open	IK-155	1200
200	G.E. S.B. Open 2200 v.	IK	1200
200	G.E. S.B. Open	IK	900
200	G.E. S.B. Open	K-6335	900
150	Wagner TEFCSB	588	1800
150	G.E. S.B. Drip	K-8824	1800
150	West. S.S.B. Open	CS-771-C	1800
150	Al. Chal. S.B. Open	AR	1800
150	West. S.B. Open 2200V	CS	1800
150	West. S.B. Drip	CS-772	1200
150	G.E. S.B. Open	KT	1200
150	G.E. S.B. Open	KT-557	1200
150	Ideal S.B. Drip New	A-586	1200
150	Al. Chal. TEFCSB	AZ	900
150	F.M. S.B. Open	H-24A	900
150	G.E. S.B. Open	IK	720
150	G.E. S.B. Open	IK	720
150	West. S.S.B. Open	CS-876-C	600
125	G.E. TEFCSB	K	3600
125	Burke S.B. Open 440 Volt	N-506	3600
125	Reliance T.E.F.C. S.B.	AA-5084	1800
125	G.E. S.B. Open	IK	1800
125	G.E. S.B. Splash	K-505	1800
125	West. S.S.B. Open	CS	1800
125	Al. Chal. S.B. Open	AR	1800
125	G.E. S.B. Open	KT-553	1200
125	G.E. S.B. Open	IK	1200
125	Ideal S.B. Open	A-585	1200
125	F.M. S.B. Open	N	900
125	G.E. S.B. Open	IK	720
125	G.E. S.B. Open	IK	600
100	Al Chal. T.E.F.C. S.B.	ARZ-625	3600
100	C.W. S.B. Open 2300 Volt	SC-445	3600
100	L.A. B.B. Drip New	OEX-445	3600
100	G.E. S.B. Open	KT-548	1800
100	G.E. S.B. Open	K-504	1800
100	Reliance B.B. Open	AA-5084	1200
100	West. TEFCSB	CS-770	1200
100	G.E. S.B. Open	KT-547	1200
100	Ideal S.B. Drip New	A-584	1200
100	Al. Chal. T.E.F.C. S.B. XP	28E8	900
100	F.M. S.B. Open	H28C	900
100	F.M. S.B. Open	H	720
100	F.M. S.B. Open	H	600
75	West. S.B. Open New	CS-444	3600
75	F.M. S.B. Open	H	900
75	F.M. S.B. Open	H	600
60	West. TEFCSB	CS-445	3600
60	G.E. TEFCSB	KF-445	3600
60	L.A. TEFCSB-XP	EX-445	3600
60	L.A. TEFCSB	JX-445	3600

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FREE CATALOG. This is a partial listing. We are continually changing our stock, and can fill your requirements at any time. Send for our free catalog. In Stock, fractional horsepower up to 500.

Motors, Control Equipment, AC and DC Generators, MG sets and transformers.
PHONE or WIRE us COLLECT
LARGE LINE OF SLIP RING MOTORS & CONTROLS.

POWER EQUIPMENT CO.

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Circle 541 on Reader Service Card

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HERE'S WHY —

Motors (AC) to 2500 HP
Controls to 1000HP
M-G Sets to 500 KW
Motors (DC) to 1000HP
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Turbine Gen. to 2500 KW.
Water Pumps to 2000 GPM
Speed Reducers to 2500 HP.

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- Also fast rewind service to 1000 HP, both AC & DC
- Check our Prices—All We Ask Is The Chance To Quote.

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GROSS ST., BOX 1078

JOLIET, ILLINOIS

Phones: Joliet SA. 6-1922, Chicago BI. 2-2458

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CONTROL PANELS AND PACKAGE VARIABLE SPEED DRIVES . . . ENGINEERED AND BUILT BY . . . JEC *WILL COST YOU LESS!*

Circle 542 on Reader Service Card

ELECTRICAL POWER EQUIPMENT

SLIP RING MOTORS

3 ph 60 cy 220 or 440 volts

HP	RPM	MAKE	TYPE
1500	514*	Al.-Ch.	Mill Type
1300	360*	Al.-Ch.	Mill Type
900	166*	Al.-Ch.	Mill Type
600	1800*	Gen. Elec.	M-6345B, Dppf, New
500	1200	Gen. Elec.	M-6345Z, Dppf.

*2200 volts or higher

SQUIRREL CAGE MOTORS

3 ph. 60 cy. 220 or 440 volts (*2200 volts or higher)

HP	RPM	MAKE	TYPE
1250	3600*	Al.-Ch.	ANX
800	1800	West.	CS34C
600	600*	West.	CS-44-C15 Dppf (2)
500	1200	G.E.	T-K
400	1200*	L. Allis	BB, Dppf.
400	1800	West.	BB. Dppf.

MOTOR GENERATOR SETS

KW	Make	Motor A.C.V.	Generator D.C.V.
1000	West.	4160	250
800	G.E. (3 unit)	2300/440syn.	125/250
500	West.	2300/440syn.	125/250
400	Al.-Ch.	2300/440syn.	125/250
300	West.	2300/480syn.	250
200	Rel.	2300/440syn. TS	500
200	G.E.	2300/440syn. TS	250/275

TRANSFORMERS

Special Offer — Like New

3—1250 KVA Allis Chalmers Class OA Oil filled 3ø1 ph 60 cy 84,000 Volt primary, 480 volt secondary with taps, manufactured 1955.

Write for current complete stock lists on electrical power equipment you need or send your list of surplus and used equipment for our offer.

Phone CAnal 6-2900

Our 50th Year 1910 to 1960

CHICAGO Electric Co.

1320 W. CERMAK ROAD • CHICAGO 8, ILL.

Circle 543 on Reader Service Card

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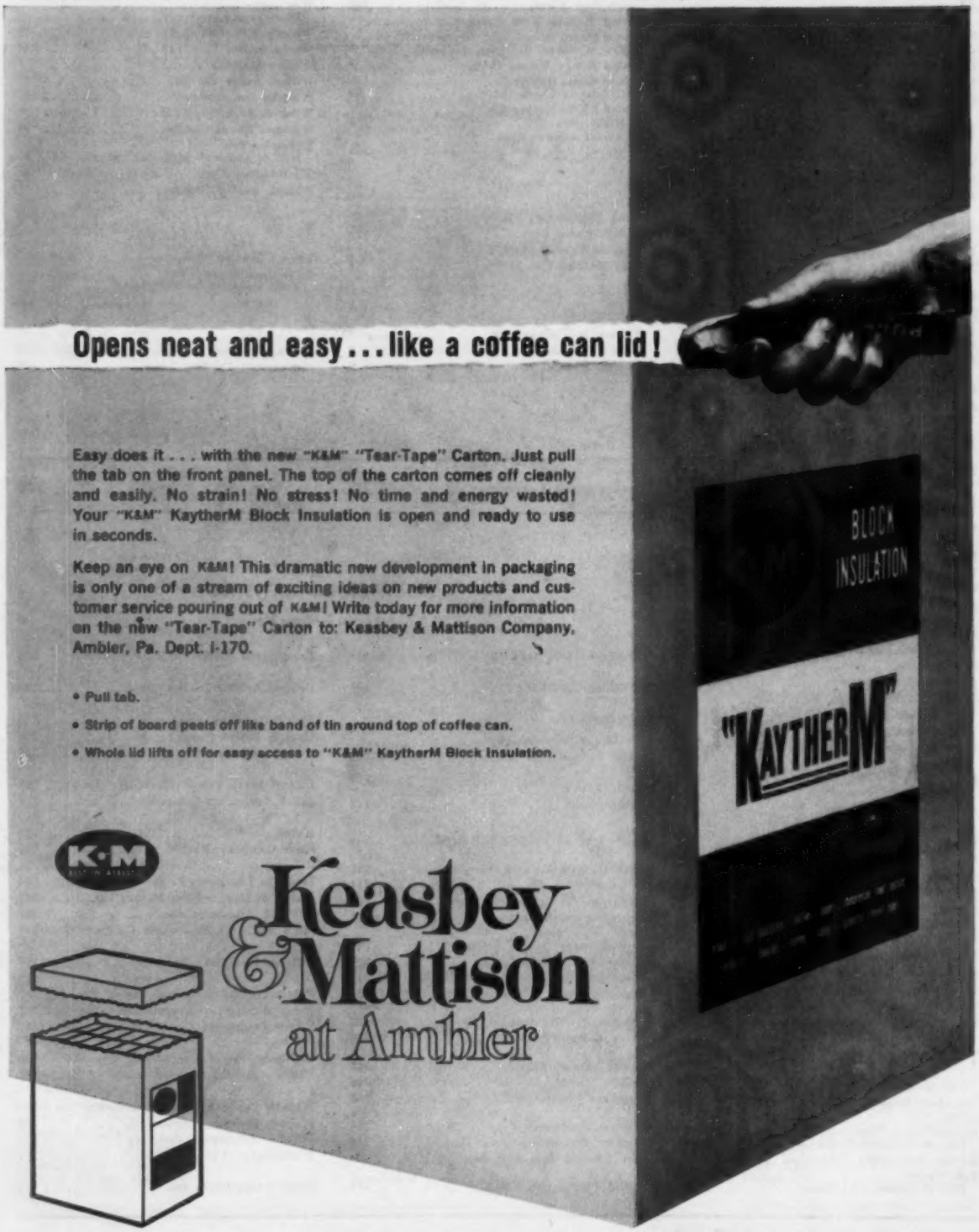
Now, the first "quick open" package for insulation products...

"K&M" TEAR-TAPE CARTON



Opens neat and easy...like a coffee can lid!

Easy does it . . . with the new "K&M" "Tear-Tape" Carton. Just pull the tab on the front panel. The top of the carton comes off cleanly and easily. No strain! No stress! No time and energy wasted! Your "K&M" KaytherM Block Insulation is open and ready to use in seconds.

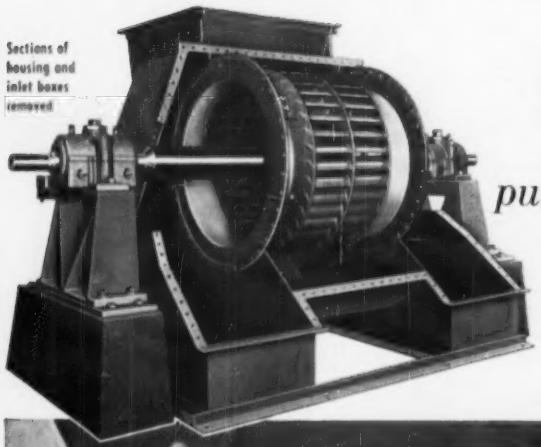
Keep an eye on K&M! This dramatic new development in packaging is only one of a stream of exciting ideas on new products and customer service pouring out of K&M! Write today for more information on the new "Tear-Tape" Carton to: Keasbey & Mattison Company, Ambler, Pa. Dept. I-170.

- Pull tab.
- Strip of board peels off like band of tin around top of coffee can.
- Whole lid lifts off for easy access to "K&M" KaytherM Block Insulation.

K·M

Keasbey & Mattison at Ambler

For more facts circle 319 on Reader Service card, p 103

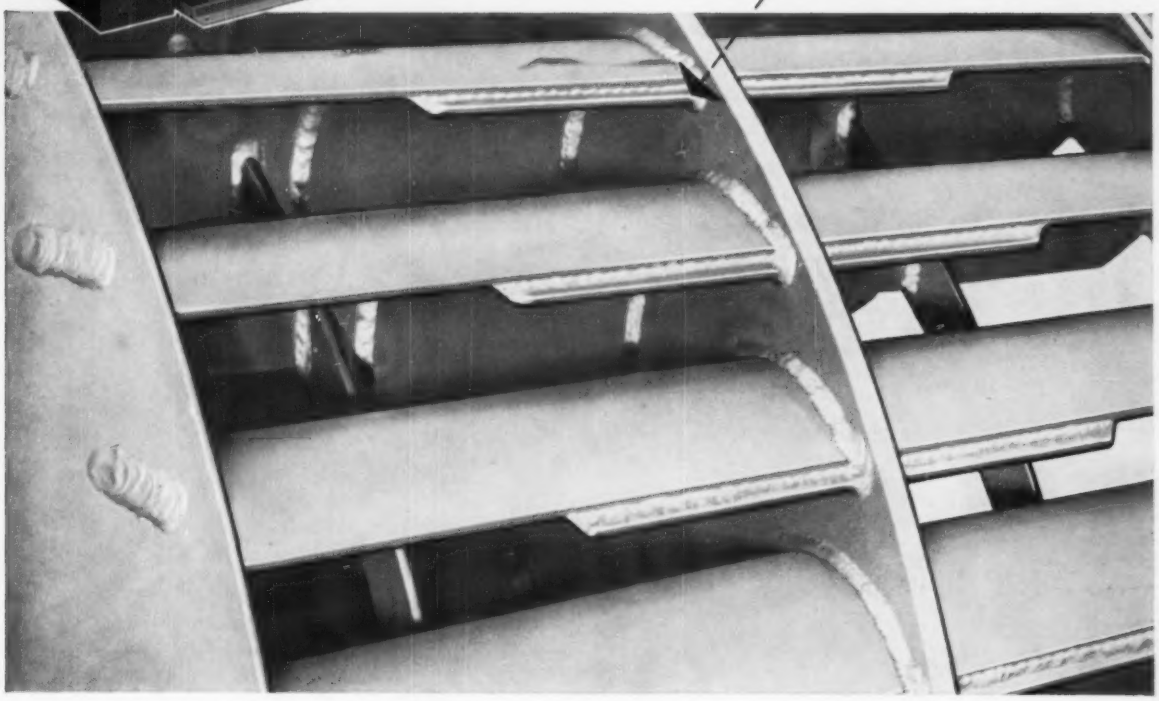


Sections of housing and inlet boxes removed

CLARAGE

puts wearing plates where they belong

on the face of the blades



DON'T SETTLE FOR LESS! Clarage makes sure you get *extra* service life on those punishing induced draft applications.

The Type DN Dynacurve fan, when equipped with wearing plates, has these abrasion-resisting steel plates welded to the *face* of the wheel blades. A distinguishing Clarage feature that guarantees you less maintenance, longer operation! But that's not all.

You get other advantages, and more, with Clarage Dynacurve fans: Minimum floor space and height requirements. Rugged wheel of 36 radially deep, aerodynamically curved blades and tapered rims. *Bolted* scroll liners for easy replacement. High efficiency over a wide performance range.

For *complete* information, contact our nearest office or write for Catalog 905.

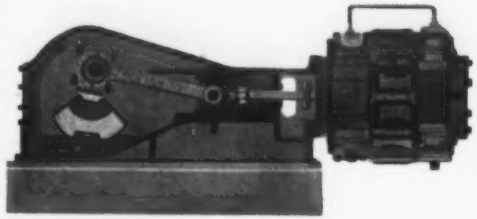
Dependable equipment for making air your servant

CLARAGE FAN COMPANY

Kalamazoo, Michigan

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

For more facts circle 202 on Reader Service card, p 103



HIDDEN VALUES?

Are they all in Worthington Horizontal Compressors?

Frankly, they're not. And we're glad! One of the "hidden values" listed below we'd hate to sell—see if you can tell which one it is. (Correct answer on page 201.)

On the other hand, we're extremely happy to be selling horizontal compressors with the other 24 "hidden values" built in. (Not everyone does.)

Frankly, we could drop many of these and 99 users out of 100 might never know it. But the 100th could suffer untold expense . . . so we keep them all for everyone. To buy these "hidden values", please contact your local Worthington representative next time you specify a compressor. Worthington Corporation, Compressor and Engine Division, Buffalo, N. Y. 36-10

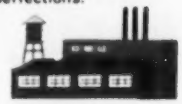
SALES AND SERVICE INTEGRATION recognizes kinship of one to the other. One man administers both.

MAGNAFLUX AND MAGNAGLO inspections are widely used to expose surface imperfections.

ULTRASONIC TEST — an advanced method of examining certain critical parts for internal quality.

ACCESSIBILITY — valves, packing and main parts are easily observed and reached by operators.

ADJUSTABLE ROLLER MAIN BEARINGS feature low friction losses which help to extend compressor life.

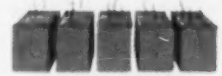


INTEGRATED DIV. includes foundry, manufacturing, sales, service and engineering in one location.

FEATHER VALVE — industry's preferred compressor valve—is efficient, quiet, and low in maintenance.

CAPACITY CONTROL —choice of simple bypass, through dual to complex sequential control systems.

FLEXIBILITY — oil or non-lube; single or multi-stage; Worthington MVD, direct or geared drive.



PARCO-LUBRITING of critical wearing surfaces completely eliminates most start-up scuffing problems.

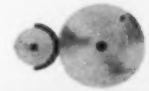
ONE-PIECE FRAME includes built-in housing with full foundation support to minimize stresses.

2000 CRAFTSMEN, these units built by same men who design and build large 5000 hp, 15,000 psi units.

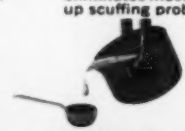
KOLENE PROCESS removes impurities from crankpin bearing shell that weaken bond to babbitt.

OPTIC COMPARATOR is used to check connecting rod bolt threads for uniform angles, lead and form.

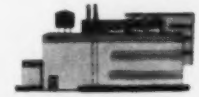
FACTORY ASSEMBLY and shop run-in on air insure proper operation and reduce installation costs.



FINISHED GROUND BEARING SHELLS provide crankpin positive full-contact backing for long life.



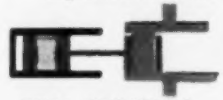
COMPOSITION TEST determines constituents of molten iron in each ladle before any casting is poured.



$1,000,000 ADDITION TO LABORATORY assures sound equipment designs based on actual research.

COUNTERWEIGHTED CRANKSHAFT eliminates vibration and insures a smoother operation.

DISTRIBUTORS — over 200 in major markets give local supply and close contact with Worthington offices.



FULL-FLOATING WRISTPINS in piston give minimum piston and cylinder wear and reduce maintenance.

STOCKING PROGRAM standard air and gas gathering units are kept in stock to give short shipments.

PROFILOMETER inspection of highly finished parts assures easy break-in and long life.

THERMODYNAMICS SECTION analyzes special application to size unit and determines performance.

DESTRUCTION TEST of complete compressor cylinders verifies engineers' design calculations.

WORTHINGTON